Final report

OWMC
Ontario
Waste Management
Corporation

A provincial crown corporation

Gartner
Lee
Associates
Limited

SITE SELECTION PROCESS - PHASE 4A:
SELECTION OF A PREFERRED SITE(S)
SURFACE WATER

FOR

ONTARIO WASTE MANAGEMENT CORPORATION

BY

GARTNER LEE ASSOCIATES LIMITED

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OCTOBER, 1985

Gartner Lee
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October 28, 1985.

Dr. B.D. Mitchell,
Director of Corporate Planning
and Development,
Ontario Waste Management Corporation,
2 Bloor Street West,
11th Floor,
Toronto, Ontario.
M4W 3E2.

Attention: Mr. J. G. Micak,
Manager, Environmental Projects

Dear Dr. Mitchell:

Re: Final Report, Site Selection Process Phase 4A:
Selection of a Preferred Site(s) - Surface Water

We are forwarding the final edition of the Phase 4A surface water report.

This report constitutes the main Phase 4A surface water document and contains our work scope, approach, factors and the results of the comparative evaluation of the candidate sites. Forwarded under separate cover is a companion technical appendix, discussing the surface water setting of each of the eight sites. The technical appendix contains the data base used in our comparative evaluation.

We thank you for this opportunity to be of service and trust that our report fulfills your requirements.

Yours very truly,

GARTNER LEE ASSOCIATES LIMITED

Grant Anderson

E.G. Anderson, P.Eng.,
Project Director.

JEO:jcm
Encl.

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EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

Surface water studies were undertaken by Gartner Lee Associates Limited and its sub-consultant M. M. Dillon Ltd. to assist the Ontario Waste Management Corporation in its "Facilities Development Process" to establish facilities for the treatment and disposal of liquid, industrial and hazardous wastes ("special wastes") in the Province. The purpose of this report is as follows:

- to identify, describe and apply surface water factors used during the Phase 4A site selection process,
- to document how those factors were utilized to assist OWMC in selecting a preferred site(s), and
- to document the methods and findings of surface water investigations undertaken for the eight candidate sites and their vicinities.

REPORT ORGANIZATION

- This report is presented in two volumes. This volume describes the site selection process and compares each of the sites on the basis of surface water considerations.

- A separate Technical Appendix describes the existing surface water conditions at the eight candidate sites and discusses data sources, analysis methods and includes data maps.

SCOPE

The scope of the Phase 4A surface water investigations consisted of:

- a consideration of flooding, drainage improvements and the potential for water use interference downstream from the facility site(s) and access road stream crossings;

- compilation of a data base consisting primarily of secondary source information available from published and unpublished sources; e.g. MOE Permits To Take Water files;

- field investigations to measure culvert and bridge capacity and to observe drainage characteristics of the sites and site vicinities;

- office analysis of the compiled data;

- discussion of the site setting results with citizen groups and feedback to assist in final site descriptions;

- meetings with public interest groups and citizens at workshops to discuss factor selection and ranking;

- input from the site selection team and client to facilitate incorporation of the surface water findings into the site selection process, and

- documentation of the surface water findings in a site selection report.

APPROACH

The process of identifying a preferred site(s) was guided by the following site selection goals:

- minimize risk to human health;
- minimize environmental impact; and
- minimize costs to OWMC and the people of Ontario.

- The Phase 4A site selection process occurred in four steps.

  1. The identification of factors, the collection of data and data analysis.

  2. The comparison of alternatives within each siting option. This involved the refinement of site acquisition boundaries and the selection of preferred alternatives with respect to local access routes, rail access and the placement of the physical/chemical treatment plant with the landfill or with the incineration plant.

3. The detailed comparison of siting options. Associated with this stage was a consideration of basic acceptability and potential mitigative measures.

4. The ranking of siting options and documentation of findings.

PREMISES AND POSTULATES

The general approach followed during Phase 4A including the identification and evaluation of siting options and alternatives within each option in a form suitable for integration into the overall site selection process was coordinated by M.M. Dillon Limited and adopted by the site selection team. The identification of the appropriate scope and scale of the study, the approach to data collection and analysis and procedures for comparative evaluation of options were established by the individual technical consultants in consultation with M.M. Dillon Limited and OWMC staff. Information on facilities characteristics and contaminants that may potentially be released from these facilities was provided by Monenco Limited, M.M. Dillon Limited and OWMC staff.

The reader should refer to the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection (M.M. Dillon Limited, 1985a) for a detailed discussion of the site selection process.

Siting options included fully integrated sites, where all facility components would be located at one site and partially

integrated sites where there was the choice of locating the physical/chemical treatment plant with the landfill or the incineration plant. Also included for consideration were access roads to the sites and between the sites. Proposed site acquisition boundaries were established by OWMC as a result of the Phase 3B analysis. Access road options were identified both during Phase 3B and the initial stage of Phase 4A by the M.M. Dillon Transportation consultant.

FACILITY CHARACTERISTICS ASSUMPTIONS

Key facility characteristics are identified in the engineering reports titled Status Report, Facility Design (Monenco Limited, 1985a) and Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Engineering (Monenco Limited, 1985b). The key facility characteristics assumptions that applied to the surface water studies concerned the methods used to collect and dispose of drainage and process waters. Generally these assumptions state that process waters and contaminated storm water will be treated on site and will not be discharged to local watercourses.

Facility characteristics assumptions and other assumptions that pertain only to surface water studies are discussed in Sections 1.4 and 1.5 of the report.

DATA SOURCES

- Data sources included: topographic maps, air photographs, published reports, open files and personal communications with numerous agency and public contacts.

- Data were obtained through meetings and discussions with various agencies and local interest groups, site inspections with local residents and roadside visits to make observations and measurements.

DATA ANALYSIS METHODS

- Data analysis tasks were undertaken for the following major areas of study: flood susceptibility, drainage improvement considerations and potential impact on surface water use.

- The main flood susceptibility analysis included: air photograph interpretation of flood-prone areas, mapping of Regional Storm Floodplains available from Conservation Authorities, calculation of runoff potential for storms of various return frequencies and calculation of the conveyance capacity of existing culverts and bridges.

- The water use analysis included the preparation of various data summaries and maps depicting water use, technical information and spatial relationships and the measurement of access road crossings of streams and downstream water use indices.

FACTORS USED IN THE REFINEMENT OF SITING OPTIONS

- Seven surface water factors were identified and used during the refinement of siting options. This step

involved the refinement of site boundaries, identification of preferred access routes, rail access, and locations of the physical/chemical plant for partially integrated siting options. The surface water factors were used to identify concerns such as flood susceptibility, drainage, and water use.

FACTORS USED FOR THE COMPARATIVE EVALUATION OF SITING OPTIONS

- Three surface water risk factors were identified and used during the detailed comparative evaluation of siting options. The factors were used to identify and examine concerns such as susceptibility of site to flooding, potential for water use interference and transportation risk to surface waters.

- Data regarding drainage improvement considerations were collected and provided to the engineering consultant (Monenco Ltd.) for inclusion in the cost analysis.

FINDINGS AND CONCLUSIONS

- The basic acceptability analysis indicated that all of the six siting options considered were suitable for development of OWMC's facilities from the surface water perspective assuming that the surface water team's recommended drainage improvement considerations are addressed.

- On May 31, 1985 OWMC announced that candidate site LF-2N was dropped from further consideration because it failed to provide adequate natural containment, (Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Interim Site Selection Report Candidate Site LF-2N, M.M. Dillon Limited, 1985c).

- The ranking of the remaining six siting options on the basis of flooding and water use from most preferred to least preferred was:

  - LF-1E
  - LF-1E/PI-27E
  - LF-9C
  - LF-4N/PI-1N
  - LF-3C
  - LF-4N/PI-13N

- Siting Option LF-1E was the preferred option. It had the lowest intensity of water use of all siting options. Flooding constraints were considered to be minor and easily corrected.

- LF-1E/PI-27E was ranked second. This site was only slightly less preferred than LF-1E. Water use downstream from this siting option was low. Some minor flooding constraints were identified on site PI-27E with respect to Grassy Brook; however, the physical/chemical plant and incineration plant can be located away from this flooding concern.

- LF-9C was ranked third. It was considered to have relatively moderate constraints with respect to the surface water use factor. No use of streams for potable water supply was identified in the downstream site vicinity. The site was considered to have minor flooding constraints that can be corrected easily.

- LF-4N/PI-1N was ranked fourth. The water use downstream from the facility was slightly higher than LF-9C but was also considered to be a relatively moderate constraint. No use of streams for potable water supply was identified in the downstream site vicinity. A relatively moderate flood constraint was identified for LF-4N. The flooding concern was with respect to the proximity of the Indian Creek floodplain; however, it was possible to avoid this floodplain when preparing the facility layout.

- LF-3C was ranked fifth. This option was considered to have a relatively moderate constraint for the surface water use factor similar to LF-9C but slightly more constrained. It was also considered to have the highest relative constraint level with regard to flood susceptibility as a result of the proximity of the Beaver Creek and Welland River floodplains.

- LF-4N/PI-13N was the sixth and least preferred siting option. The occurrence of potable water uses from streams downgradient from the facilities in the site vicinity, coupled with the relatively high occurrence of water use on a regional scale was the main reason for this

site's low rating. Flooding constraints were associated with LF-4N (discussed above) and were considered to be avoidable.

STUDY TEAM

This study was carried out under the direction of Grant Anderson, Project Director, Gartner Lee Associates Limited. The study team included:

Project Management	-	Ted O'Neill
Project Hydrologists	-	James McLean
	-	Craig MacRae
Technical Advisor	-	Dave Osmond

M.M. Dillon Limited was a sub-consultant on this project responsible for the flood susceptibility and drainage improvement analysis. The Dillon study team included:

Project Management	-	Allan Mitchell
Project Hydrologist	-	Wayne Concessi

1.0 INTRODUCTION

1.1 BACKGROUND

The Ontario Waste Management Corporation (OWMC) is conducting a five-phase "Facilities Development Process" to establish facilities for the treatment and disposal of liquid industrial and hazardous wastes ("special wastes") in the Province (Figure 1). This process has resulted in the identification of eight candidate sites for development of various facility components within the Golden Horseshoe of southern Ontario. Candidate site locations are shown in Figure 2.

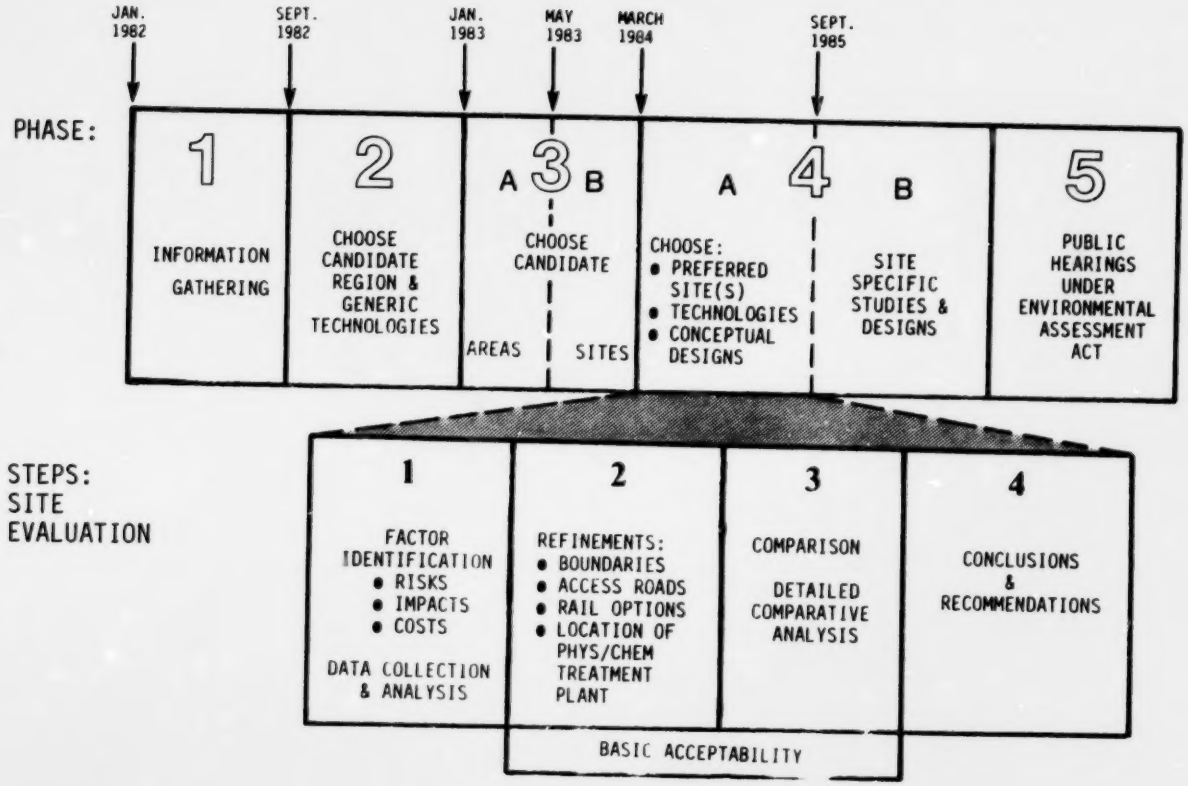
Phase 4A (the present stage) involves the detailed comparison of eight candidate sites and the identification of a preferred siting option. Phase 4B will involve detailed on-site testing of the selected site(s).

The OWMC site selection process is directed towards three site selection goals, identified below:

1. to minimize risk to human health;
2. to minimize environmental impact; and
3. to minimize financial cost to OWMC and the people of Ontario.

Surface water was one of several disciplines involved in the site selection process. Gartner Lee Associates Limited (GLAL) was responsible for addressing surface water considerations. M.M. Dillon Limited was employed by Gartner Lee

FIGURE 1 FACILITIES DEVELOPMENT PROCESS - PHASE 4A: SELECTION OF A PREFERRED SITE(S)



Source: OWMC, 1985. FACILITIES DEVLEOPMENT PROCESS - PHASE 4A REPORT

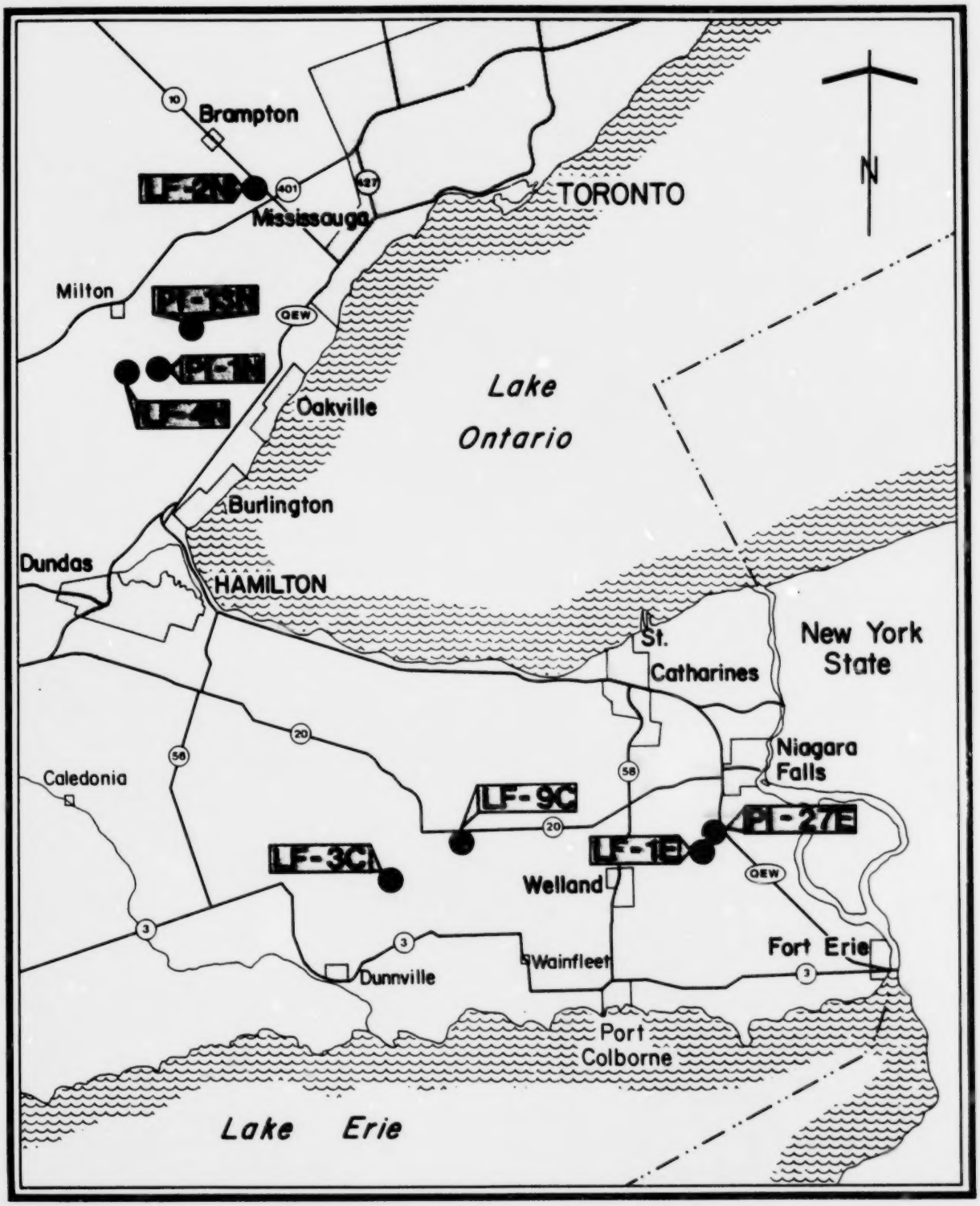


FIGURE 2 LOCATION OF CANDIDATE SITES

Associates Limited to address flooding and drainage considerations.

1.2 PURPOSE

This report:

1. identifies, describes and applies surface water factors used during the Phase 4A site selection process for OWMC's waste treatment facilities,

2. documents how these factors were utilized to assist OWMC in selecting a preferred siting option, and

3. documents the methods and findings of the surface water investigation undertaken for the eight candidate sites and their vicinities.

1.3 SCOPE AND APPROACH

1.3.1 SCOPE

The purpose of the data collection and analysis tasks in Phase 4A was to permit a comparative evaluation among sites. Surface water issues addressed during Phase 4A included: flooding, drainage improvement considerations, and the potential for water use interference downstream from site(s) and access road crossings.

To differentiate among siting options a detailed data base was assembled. This data base consisted primarily of existing data from published reports and agency files as well as unpublished information provided by local residents. Phase

4A field investigations were of an overview nature and consisted primarily of culvert and bridge measurements used in the flooding analysis. Detailed on-site investigations such as in-stream water quality testing to determine background conditions were not considered necessary for site selection purposes. Similarly, air photograph interpretation was considered an acceptable method of determining flood-prone areas for the site selection process.

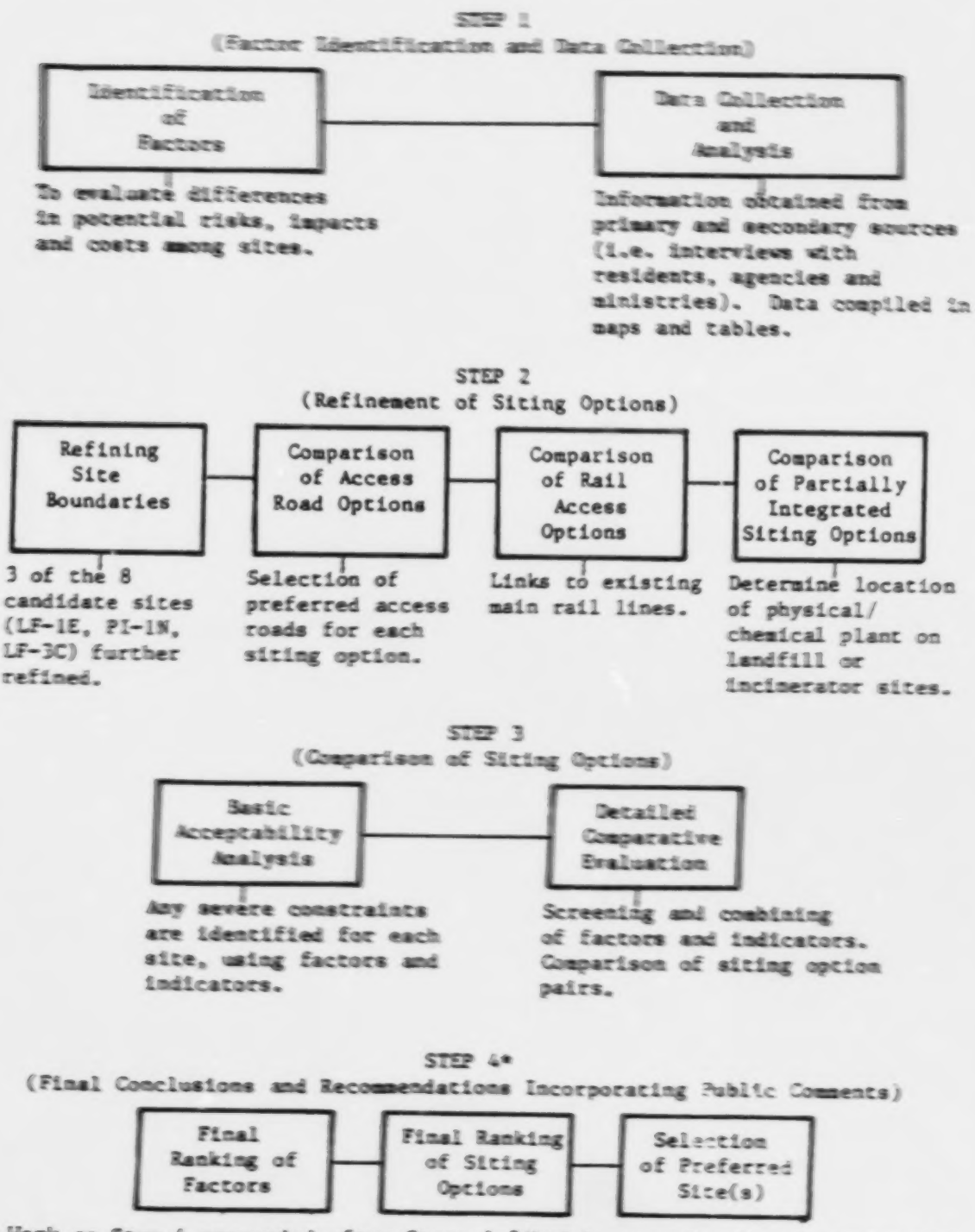
1.3.2 SITE SELECTION PROCESS

The Phase 4A site selection process occurred in four steps as depicted in Figure 3. Step 1 concerned the identification of factors, the collection of data and data analysis. The second step involved the refinement of siting options. This involved the selection of preferred alternatives with respect to site acquisition boundaries, access routes, railway lines and the placement of the physical/chemical treatment plant with the landfill or the incineration plant. The third step involved the detailed comparative evaluation of the siting options. Associated with this step was a consideration of basic acceptability and mitigation measures. The final step of the process involved the comparison and ranking of siting options and the documentation of our findings. For a detailed discussion of the site selection process the reader should refer to the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection, (M.M. Dillon Limited, 1985a).

1.3.3 APPROACH

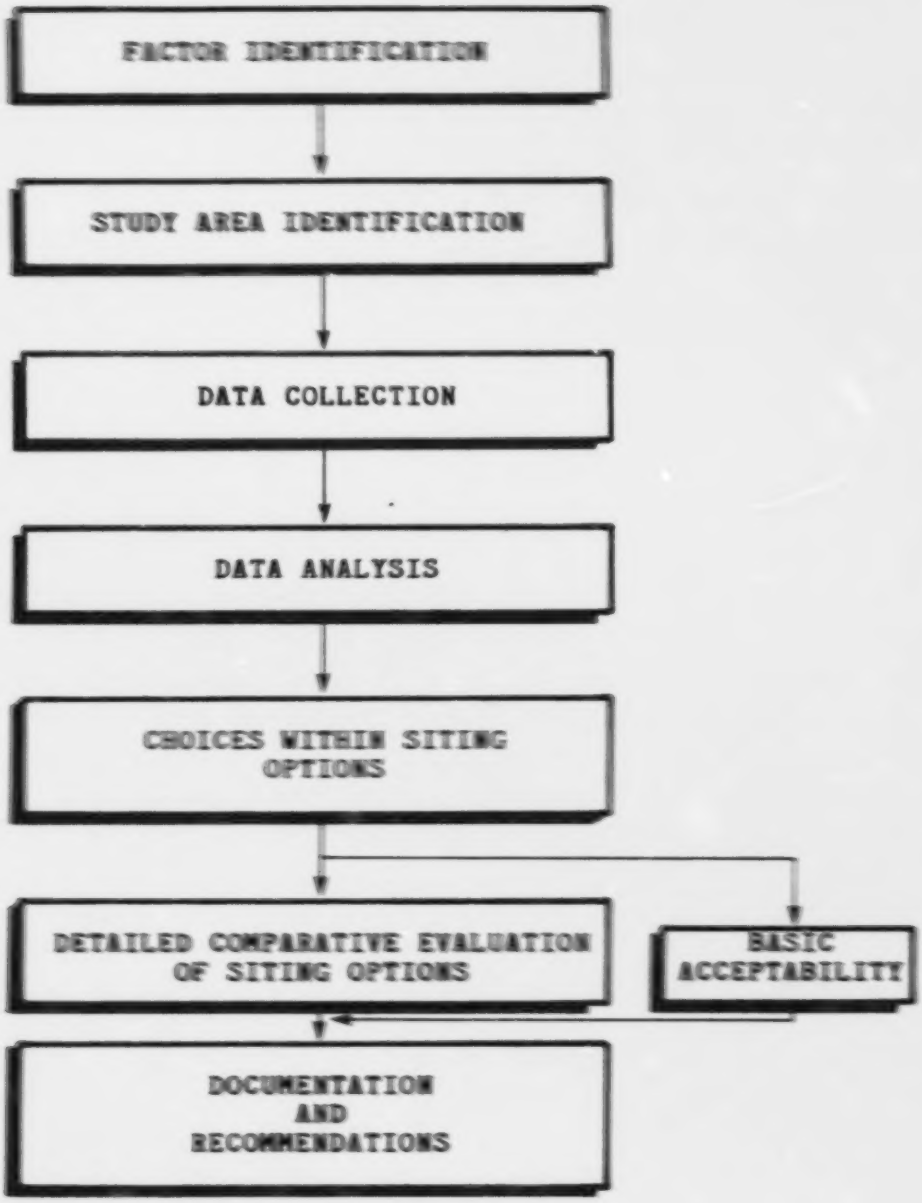
The general study approach used by the surface water team in the Phase 4A site selection process is shown in Figure 4 and described below.

FIGURE 3 PHASE 4A SITE SELECTION PROCESS
(FROM: M.M. DILLON LIMITED, 1985a)


STEP 1
(Factor Identification and Data Collection)
Identification of Factors
Data Collection and Analysis
To evaluate differences in potential risks, impacts and costs among sites.
Information obtained from primary and secondary sources (i.e. interviews with residents, agencies and ministries). Data compiled in maps and tables.
STEP 2
(Refinement of Siting Options)
Refining Site Boundaries
Comparison of Access Road Options
Comparison of Rail Access Options
Comparison of Partially Integrated Siting Options
3 of the 8 candidate sites (LF-1E, PI-1N, LF-3C) further refined.
Selection of preferred access roads for each siting option.
Links to existing main rail lines.
Determine location of physical/ chemical plant on landfill or incinerator sites.
STEP 3
(Comparison of Siting Options)
Basic Acceptability Analysis
Detailed Comparative Evaluation
Any severe constraints are identified for each site, using factors and indicators.
Screening and combining of factors and indicators. Comparison of siting option pairs.
STEP 4*
(Final Conclusions and Recommendations Incorporating Public Comments)
Final Ranking of Factors
Final Ranking of Siting Options
Selection of Preferred Site(s)

* Work on Step 4 proceeded after Steps 1-3 had been reviewed with the public in planned meetings and workshops.

FIGURE 4 STUDY APPROACH USED IN THE PHASE 4A SITE SELECTION PROCESS



1.3.3.1 Factor identification

At the beginning of Phase 4A a number of surface water factors were identified. The purpose of these factors was to provide a basis for the identification and evaluation of differences and similarities among the candidate sites. Factors reflected OWMC's site selection goals of minimizing risk, impact and costs associated with the development of the facilities as well as the characteristics of the candidate sites, surrounding area and access routes.

Surface water factors were identified that addressed flooding, site drainage, and water usage downstream from the facility site and access route crossings. Factors and considerations used in the refinement and comparison of siting options are listed in Table 1 and are defined in factor sheets presented in Appendix A. A detailed discussion of factors is contained in Sections 2 and 3 of this report.

1.3.3.2 Study area and time frame identification

Various study areas were chosen for purposes of collecting information on the factors. These study areas are listed in Table 1. The "site" study area relates to flooding factors and consists of the candidate sites, as indicated by the site acquisition boundaries. Immediately adjacent watercourses (e.g. within a few hundred metres) were also included in this study area due to their potential to flood the site.

The 'site vicinity' study area related to the potential for water use interference downstream from the site. This study area consists of watercourses downstream from the candidate sites to a point approximately 2 km from the site. This downstream study area was established to identify

TABLE 1 STUDY AREAS AND TIME FRAMES USED FOR FACTORS IN THE REFINEMENT AND COMPARISON OF SITING OPTIONS

FACTOR AND CONSIDERATIONS	STUDY AREA					TIME FRAME		
	SITE	SITE VICINITY	REGIONAL	ACCESS ROADS	RAIL	CONSTRUCTION	OPERATIONAL	POST-OPERATIONAL
1. REFINEMENT OF SITING OPTIONS								
1.1 SITE BOUNDARY REFINEMENT								
1.1.1. Flood susceptibility	X					X	X	X
1.1.2. Downstream water use		X	X			X	X	X
1.2 IDENTIFICATION OF PREFERRED ACCESS ROUTES								
1.2.1. Transporation risk to surface water			X	X			X	
1.3 IDENTIFICATION OF RAIL ACCESS ROUTES					X			
1.3.1. Number of stream crossings						X	X	
1.4 IDENTIFICATION OF RAIL ACCESS ROUTES - DETAILED COMPARATIVE EVALUATION								
1.4.1. Number of stream crossings					X	X	X	
1.4.2. Proximity of floodplains and flood-prone areas					X	X	X	
1.5 LOCATION OF PHYSICAL/CHEMICAL TREATMENT PLANT FOR PARTIALLY INTEGRATED SITING OPTIONS								
1.5.1. Surface water suitability				X			X	
1.6 BASIC ACCEPTABILITY								
1.6.1. Avoidance of floodplains	X					X	X	X
1.6.2. Water use		X	X			X	X	X
1.6.3. Transporation			X	X			X	
2. COMPARISON OF SITING OPTIONS								
2.1 SURFACE WATER SUITABILITY								
2.1.1. Susceptibility of the site to flooding	X					X	X	X
2.1.2. Potential for downstream water use interference		X	X			X	X	X
2.2. TRANSPORATION RISK								
2.2.1. Surface water suitability			X	X			X	

sensitive water users that could potentially be affected by contaminants entering surface waters from the facility. Water users in close proximity to the facility are of greater concern than similar users further downstream. This is because the potential for instream dilution of contaminants is less and the time available to notify users of possible contamination in the event of a spill is shorter in the immediate downstream study area. The 2 km distance was also chosen for consistency with the 2 km site vicinity study area boundary used by other consultants.

The 'regional' study area relates to the potential for water use interference from the facility and access routes. This study area consists of watercourses downstream from the facility and its access routes. The study area extends along the downstream watercourses to a point where they discharge to a body of water with very large dilution capability such as Lake Erie, Lake Ontario, or the Chippawa/ Queenston Power Canal.

The 'access roads' study area relates to the potential for spilled wastes to enter a stream. This study area includes both local and regional access roads but not 400 series highways.

The 'rail' study area relates to the provision of rail access to the candidate sites. The study area consists of broad corridors from the closest main rail line to the site boundary.

The time frames over which the factors apply are also identified in Table 1. The 'construction' time frame refers to the period of construction prior to the opening

of the facilities. The 'operational' time frame refers to the period during which the facility is in service and 'post-operational' refers to the period following closure of the facility.

1.3.3.3 Data collection

In addition to the review of on-hand data and material obtained during previous OWMC phases, three distinct approaches were used to collect data for the Phase 4A surface water studies.

These were:

- meetings and discussions with various agencies,
- meetings, discussions and site inspections with local residents; and
- roadside visits to make observations and measurements.

Data sources included topographic maps, air photographs, published reports, open files and personal communications from numerous agency and public contacts. For a detailed discussion of data collection methods and listing of reports, meetings, contacts, etc. refer to the companion Technical Appendix.

1.3.3.4 Data analysis

Data analysis tasks were undertaken for the following major areas of study: flood hazard, drainage improvement considerations and the potential impact on surface water usage. The analysis techniques used included:

- air photograph interpretation of flood-prone areas;
- calculation of runoff potential for storms of various return frequencies;
- the calculations of the conveyance capacity of existing culverts and bridges;
- the preparation of various data summaries and maps depicting technical information and spatial relationships; and
- the measurement of access road and stream lengths.

Data analysis methods are described in detail in the companion Surface Water Technical Appendix.

1.3.3.5 Choices within siting options

Once the data analysis task was complete, a series of options were evaluated before it was possible to compare the candidate sites. These included:

- site acquisition boundaries,
- access roads,
- rail access, and
- the placement of the physical/chemical treatment plant for partially integrated siting options.

This refinement of siting options step is discussed in detail in Section 2.0 of this volume.

1.3.3.6 Basic acceptability

In the basic acceptability analysis, new data collected in Phase 4A for all factors were reviewed to determine whether or not there were any situations where a site should be rejected irrespective of its relative suitability. From the surface water perspective the basic acceptability analysis focused on flood susceptibility, i.e. the avoidance of locating operational areas of the facility on floodplains, the avoidance of major sensitive water uses (downstream) and access routes. This analysis took place parallel to the comparison of siting options.

1.3.3.7 Detailed comparative evaluation of siting options

The facility siting options defined in the previous steps were evaluated by the site selection team to identify preferred siting options. The contributions of the surface water team are discussed in detail in Section 3.0 of this report.

In general, the evaluation procedure consisted of the following:

- screening (review and where warranted, elimination of factors and/or indicators because of no significance, duplication of measurements, etc.);
- scaling of indicators to highlight relative differences among siting options;
- aggregation of indicators (ranking and combining of indicators within factors into a single relative suitability rating); and

- aggregation of factors (ranking and combining of factors within factor groupings into a single relative suitability rating); and

- ranking of siting options.

Siting options were compared on the basis of relative suitability ratings and a number of assumptions. For example, we assumed that drainage improvement considerations would be part of the facility design, e.g. on-site stormwater management ponds, channel/bridge improvements, berms etc.

1.3.3.8 Documentation and recommendation

Recommendations regarding refinement of siting options and the comparison of siting options were made by the site selection team. A comprehensive documentation for the overall site selection process is contained in the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection (M.M. Dillon Limited, 1985a).

1.4 FACILITY CHARACTERISTICS ASSUMPTIONS

The Phase 4A analysis for refinement of siting options and comparison of siting options was based on several facility characteristics provided by Monenco (Status Report, Facility Design, Monenco Limited 1985a). The facility characteristics that pertain to the surface water analysis are outlined below. A summary listing of facility characteristics assumptions is contained in M. M. Dillon Limited (1985a).

1. Water from building and roof drains and grassed areas within the central operating area will be collected

in a lined storm water pond and will be discharged off-site to a suitable local watercourse, following verification of acceptable quality.

2. Potentially contaminated water from roads will be directed to a separate holding pond and also released to a local watercourse following verification of acceptable quality. If the water is found to be of unacceptable quality for release then it will be sent to the physical/chemical treatment plant for treatment.

3. Water and spills from storage areas and other areas classified as contaminated will be contained and pumped to storage tanks for treatment.

4. Uncontaminated surface drainage from within the undeveloped areas of the engineered landfill will be controlled and discharged off-site to a suitable local watercourse.

5. Surface drainage from the active working areas of the landfill will be treated as potentially contaminated. This water will be directed to holding ponds, tested, and if contaminated sent to the central operating area for treatment. If it is not contaminated, then it will be discharged off-site to a suitable local watercourse.

6. Surface drainage from completed landfill areas is expected to be uncontaminated. If this is confirmed by analysis in the early stages of landfill development it will be discharged to a suitable local watercourse.

7. Treated waste water will not be discharged to local surface watercourses. Total solidification or evaporation will be used.

1.5 ASSUMPTIONS FOR SURFACE WATER ANALYSIS

The Phase 4A analysis for surface water was based on several assumptions some of which were considered to represent worst case situations. These assumptions are outlined below.

1. Some hazardous wastes being transported are concentrated, toxic and if spilled will readily flow.

2. Spills occurring within certain zones along an access road will enter a stream and travel downstream to an ultimate receiver (e.g. Lake Erie or Lake Ontario).

3. Contaminants entering streams are toxic and may affect human health.

4. Streamflow will be insufficient to dilute spilled wastes to a safe level until the wastes reach the ultimate receivers.

5. Emergency teams will respond promptly to spills to contain and clean-up contaminants.

6. Streams that flow through rural, wooded and recreational land uses are assumed to support low volume "sensitive" water use (i.e. could afford a pathway to humans).

7. The study area for access road analysis was limited to the regional and local road systems (i.e. not 400 series highways).

1.6 REPORT FORMAT

This report for the surface water discipline is presented in two volumes.

1. Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Surface Water (this volume), and

2. Site Selection Process, Phase 4A: Technical Appendix - Surface Water Considerations for the Eight Candidate Sites (companion technical appendix).

The first volume describes the site selection process and compares each of the sites on the basis of surface water considerations. It includes a discussion of the options considered, the identification and selection of factors used to make comparative evaluations of options and the results of the comparisons.

The companion Technical Appendix describes the existing conditions at the eight candidate sites. A detailed description of the methods used for data collection and analysis is presented as well as a discussion of study findings and data tables for each of the eight candidate sites.

2.0 REFINEMENT OF SITING OPTIONS

2.1 INTRODUCTION

This chapter documents the contributions of the surface water team to the step of refining the siting options. This includes selection of preferred alternatives with respect to refinement of site boundaries, access road options, rail access options and the location of the physical/chemical treatment plant for partially integrated siting options.

2.2 REFINEMENT OF SITE BOUNDARIES

2.2.1 INTRODUCTION

The purpose of this section is to describe the procedure used to refine site boundaries for Phase 4A. There was a need to refine boundaries on sites where there was more than sufficient land within the current site boundaries to accommodate the OWMC facilities. The three sites requiring boundary refinement were LF-1E, LF-3C and PI-1N.

Site boundary refinement was undertaken by the site selection team through a constraint mapping approach. On each of the three sites, the entire site was evaluated and areas were identified where various features would constrain the siting of a facility, e.g. floodplains. Site boundaries were then modified based on consideration of constraints for all factors.

2.2.2 FACTOR IDENTIFICATION

Two surface water factors were identified for the constraint mapping exercise which contributed to the refinement of site boundaries. These factors were:

1. flood susceptibility, and
2. downstream water uses.

Flooding of the operational areas of a waste treatment facility could result in the rapid movement of contaminants to a watercourse and could pose a risk to health for downstream users. Operational components of the waste treatment facility must therefore avoid areas susceptible to flooding. The exposure of downstream water resources (and water uses) can be reduced (in the unlikely event of contaminant entry to streams) by minimizing the number of watersheds which drain the site and the number of stormwater outfalls. The potential risk to downstream water users may be further reduced by monitoring downstream water quality and if contaminated, by providing alternate water supplies.

2.2.3 DATA COLLECTION AND ANALYSIS

Constraint mapping of the flood susceptibility factor involved the preparation of 1:10,000 scale maps showing streams, drainage sub-basins, bridges/culverts and their capacities, designated floodplains and other flood-prone areas. This information was prepared on overlays and provided to the site selection team. Copies of these working maps are on file with GLAL. The data for these maps were derived from existing site and site vicinity investigations.

The downstream water use factor was mapped and quantified in terms of the number of sub-watersheds presently draining the site. This factor was included in the refinement step to enhance the control of accidental spills through confinement to one watershed. This situation would reduce the watershed area potentially affected and increase the chance for containment.

Tables 2, 3 and 4 present a summary of the data collected for each of the factors used to refine the site boundaries for the three sites. A more detailed description of data collection methods is given in the companion surface water Technical Appendix.

2.2.4 CONSTRAINT MAPPING RESULTS

This section identifies the portion of each site that is preferable for siting a facility, based on surface water considerations. The final Phase 4A site boundaries are determined by the site selection team and are documented in the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection, M.M. Dillon Limited, 1985a.

2.2.4.1 Site LF-1E

The preferred area for siting a facility at LF-1E from a surface water perspective is on the northern two-thirds of the site. This area is shown on Figure 5. This siting has the following surface water characteristics:

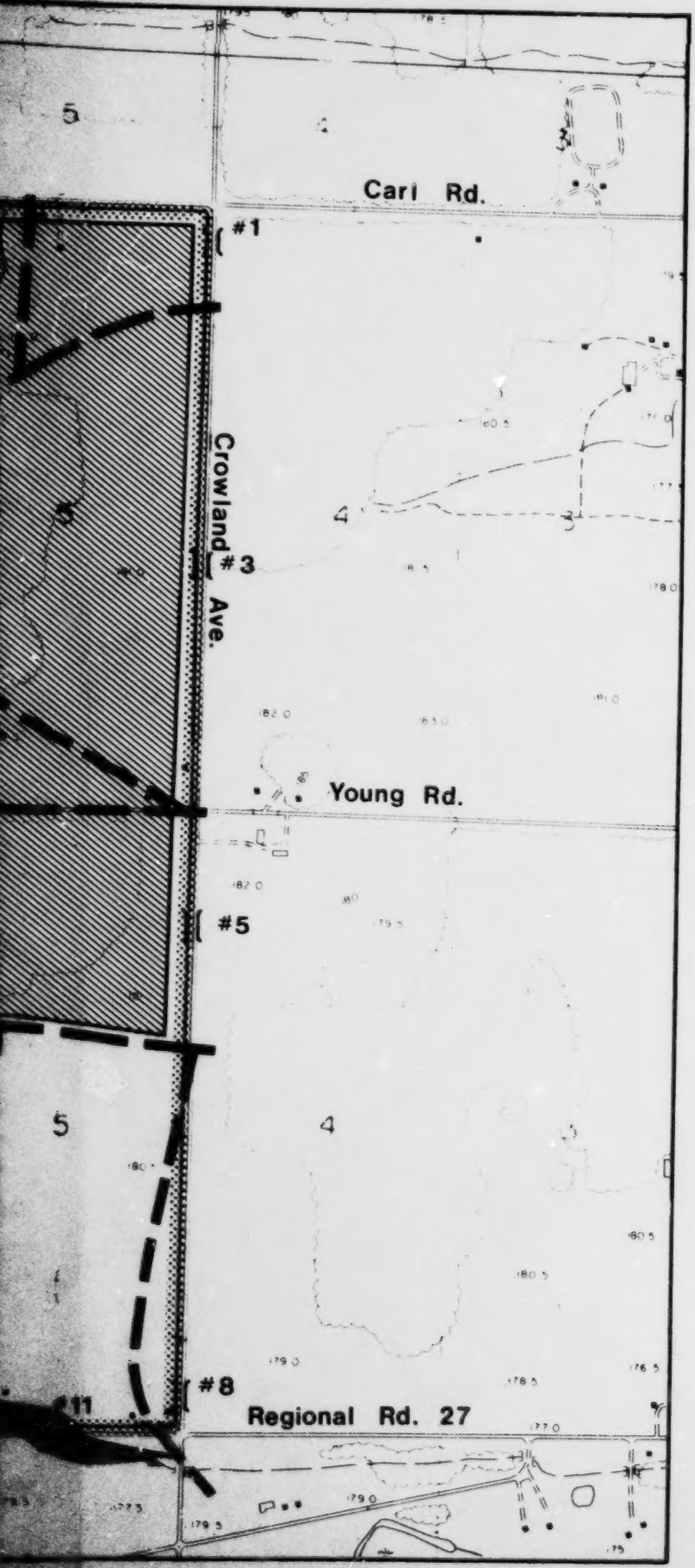
- the flooding in the swale near Regional Road 27 is avoided,
- the area of upstream land contributing runoff to the site is small, and

TABLE 2 SUMMARY OF BOUNDARY REFINEMENT DATA: LF-1E

FACTOR/INDICATOR	DATA
Flood Susceptibility	Minor flooding was reported at the Carl Road/Morris Road intersection. There are flood prone-areas in the swale near the southern boundary of the site. No land on-site has been designated as floodplain. There is poor relief for surface drainage. The total upstream area is approximately 165 ha. The maximum flow rate through the site is approximately 10 m^3/s. There are six outlet culverts from the site.* All culverts are overtopped by the 100 year return period discharge. Three culverts (in the north) are overtopped by the 5 year return period discharge. Outlet swales have mild slopes.
Downstream Water Use (Drainage Sub-basins)	This site now covers seven minor drainage sub-basins. After construction of the facility there would be two sub-basins - one flowing to the north and the other to the south

* Please refer to Figure 5 for culvert locations.

LOT 8
CON 1
LOT 8
CON 2
LOT 8
CON 3
#48
Morris Rd.
9
8
6
5



OWMC Ontario Waste Management Corporation

Consultant : Gartner Lee Associates Limited

Legend

- Channel or Swale
- Floodplain or Flood-Prone Area
- Watershed Divide
- Preferred Area for Locating Facilities
- #31 Outlet Culvert and ID Number

Key Map: LF-1 East

1000 0 feet 1000
500 0 metres 500

Site Boundary Refinement : LF-1E

October 1985 **Figure 5**

TABLE 3 SUMMARY OF BOUNDARIES REFINEMENT DATA: LF-3C

FACTOR/INDICATOR	DATA
Flood Susceptibility	
	There is a substantial floodplain area along Beaver Creek (based on a backwater elevation at the Welland River). There are two small areas of Welland River floodplain on site: - upstream from Culvert #31 on Zumstein Road* - immediately south of the Cosby farm. Under spring ice breakup conditions, the water levels in Beaver Creek, as well as all other streams in the area may be influenced by ice jams at culverts. Ice jams can cause water levels higher than those predicted by conventional floodplain mapping. This site has poor relief for surface drainage. The upstream area contributing runoff to the site is approximately 2030 ha. The maximum flow rate through the site is 34-37 m^3/s (1:100 year storm). There are 5 existing outlet culverts beneath roads. The Beaver Creek culvert is overtopped by 1:50 year storm. The rest are overtopped by the 1:5 year storm.
Downstream Water Use	
(Drainage Sub-basins)	The site drains north and south into 2 sub-basins, with the boundary approximately on the NW-SE diagonal across the site

* Please refer to the Figure 6 for culvert locations.

TABLE 4 SUMMARY OF BOUNDARY REFINEMENT DATA: PI-1N

FACTOR/INDICATOR	DATA
Flood Susceptibility	
	There is no floodplain land designated for this site. There is a small area of flood-prone land along the northeastern side of the site. There is good relief for surface drainage across the site. The watershed area upstream from Culvert #42 (to Bronte Creek) is approximately 390 ha.* The watershed area upstream from Culvert #7 (Highway 25) comprises approximately 565 ha. The storm water flow rate through the site is estimated to be 19.6 - 22.4 m^3/s for the 1:100 year storm. Culvert #42 (railway bridge) will be overtopped by the 1:100 year storm. Culvert #7 (Highway 25) is not overtopped by the 1:100 year storm. The outlet swale downstream from Culvert #7 has a slope of 0.7% compared to 0.2% for the swale downstream of Culvert #42.
Downstream Water Use (Drainage Sub-basins)	The site is drained by 2 sub-basins. The watershed divide runs NW-SE through the centre of the site. The northeastern 1/2 site drains to 16 Mile Creek through Culvert #7 at Highway 25). The southwestern 1/2 site drains to Bronte Creek through Culvert #42 at the CNR Railway bridge.

* Please refer to Figure 7 for culvert locations.

- the modified drainage after development would be from one stormwater outfall draining the northern part of the site.

2.2.4.2 Site LF-3C

The preferred area for siting a facility at LF-3C is on the southern two-thirds of the site, excluding the flood-prone areas on the southern edge of the site, as shown on Figure 6.

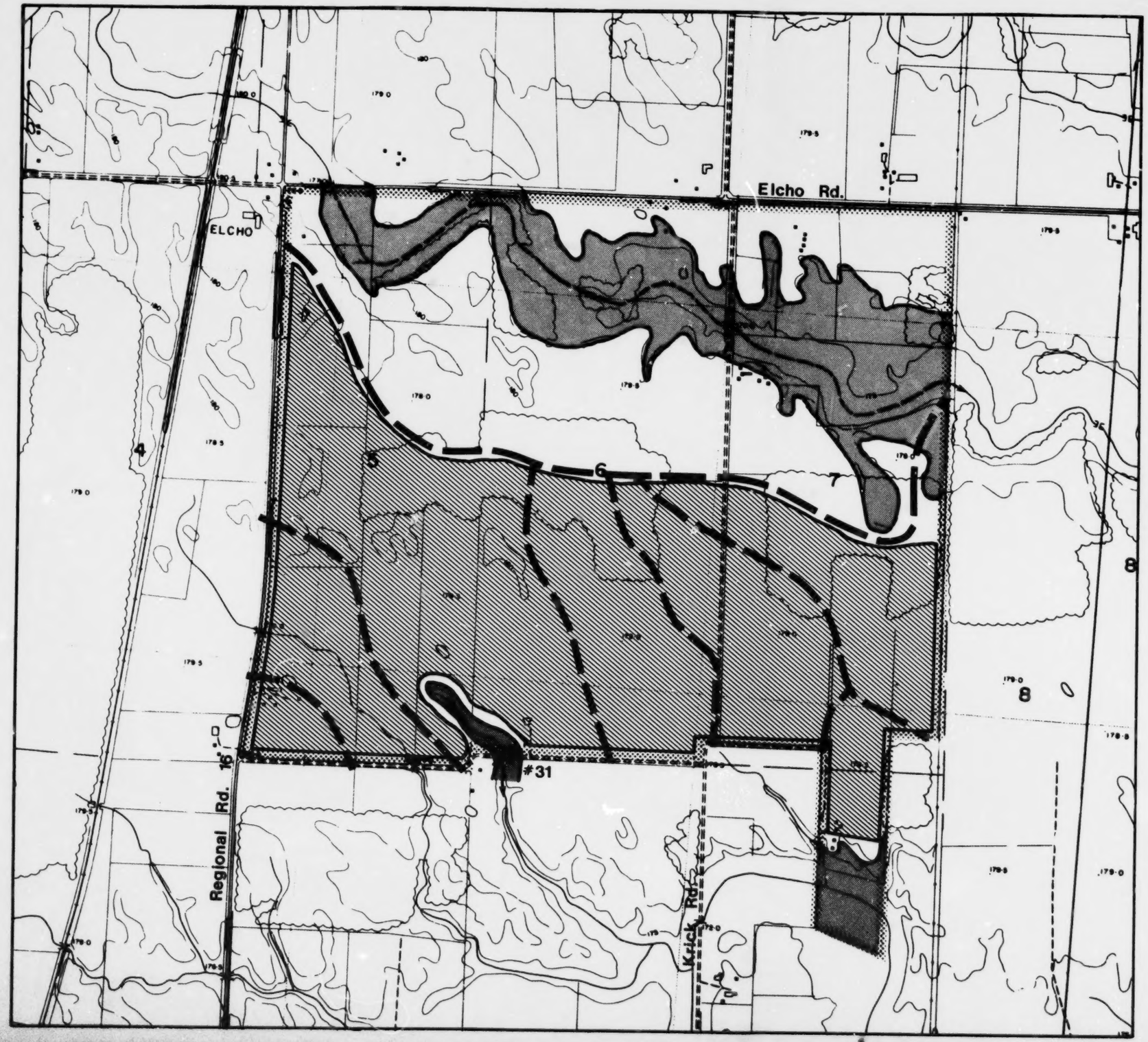
This area has the following surface water advantages:

- floodplain and flood-prone areas are avoided,
- the site will be within only one drainage basin, reducing the exposure to downstream water resources.

2.2.4.3 Site PI-1N

The preferred area for siting the facility is within the cross-hatched area in Figure 7. This area has the following attributes:

- floodplain and flood-prone areas are avoided,
- the facility would lie within only one drainage basin reducing the exposure to downstream water resources.
- the outlet at Culvert #7 has a much larger capacity than Culvert #42, thereby reducing the potential for flooding caused by inadequate outlet capacity, and the outlet swale has a generally steeper slope than the western basin, facilitating storm water drainage with a minimum of construction.



OWMC Ontario Waste Management Corporation

Consultant : Gartner Lee Associates Limited

Legend

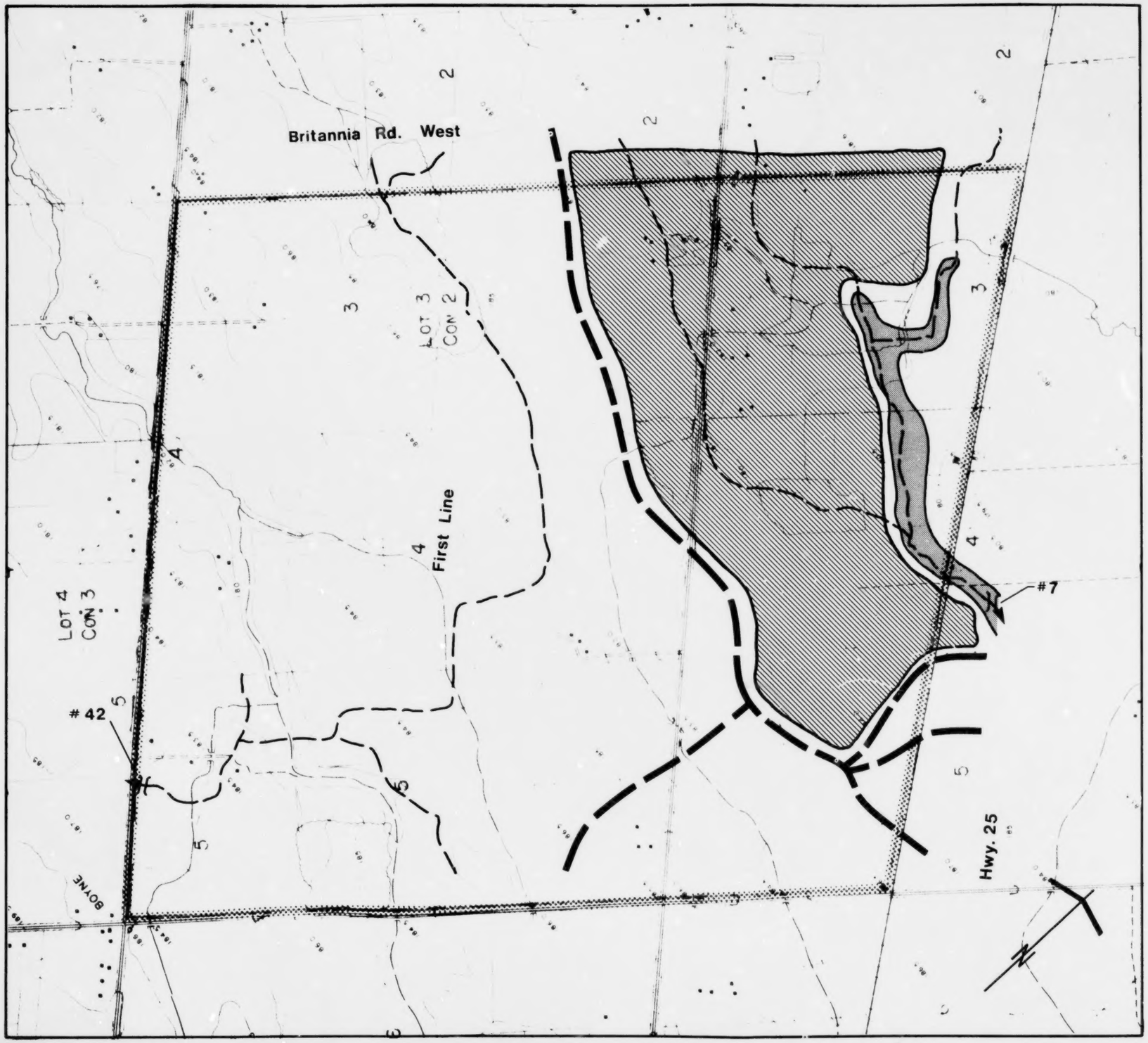
- Channel or Swale
- Floodplain or Flood-Prone Area
- Watershed Divide
- Preferred Area for Locating Facilities
-][#31 Outlet Culvert and ID Number

Key Map: LF-3 Central

1000 0 feet 1000
500 0 metres 500

Site Boundary Refinement : LF-3C

October 1985 Figure 6



OWMC Ontario Waste Management Corporation

Consultant : Gartner Lee Associates Limited

Legend

- Channel or Swale
- Floodplain or Flood-Prone Area
- Watershed Divide
- Preferred Area for Locating Facilities
-][#31 Outlet Culvert and ID Number

Key Map: PI-1 North

1000 0 feet 1000
500 0 metres 500

Site Boundary Refinement : PI-1N

October 1985 Figure 7

2.3 ACCESS ROAD OPTIONS

2.3.1 INTRODUCTION

The purpose of this section is to describe the procedure used to evaluate and rank access road options to the various facility siting options, from the surface water perspective.

Two steps were involved in the overall assessment of access road options. These steps were:

1. a preliminary evaluation of options (including new options identified since Phase 3B), and

2. a detailed comparison of the remaining options and the identification of preferred routes.

Step 1 involved the use of the Phase 3B factors and data base. Step 2 was based on use of a more extensive Phase 4A data base and analysis.

The surface water team was involved only in Step 2. In Phase 3B, surface water aspects of access road studies were undertaken by GLAL - Biology. The results are reported in the report Site Selection Process, Phase 3B: Selection of Candidate Sites - Biology (Gartner Lee Associates Limited, 1984a). Since Step 1 involved Phase 3B level of analysis and data base, it was decided that this analysis would be carried out by the GLAL - Biology study team for consistency.

The Phase 4A level of analysis that resulted in the selection of a preferred access route to each facility siting option for surface water is reported in this section.

2.3.2 FACTOR IDENTIFICATION

2.3.2.1 Basis for factor and indicator selection

The identification of factors and indicators used in the access road options analysis was based on OWMC's site selection principles, goals and objectives.

To select options that address OWMC's goals, i.e. to minimize risk to human health and to minimize environmental impact, it was first necessary to assess the "pathways" through which contaminants might move and the "receptors" that might be affected. From a surface water perspective, the pathway was considered to be downstream watercourses. The receptors were considered to be sensitive downstream water uses i.e. people who use surface water for drinking (risk to human health) and significant fisheries (impact to the environment). Details on the methods and results of the analysis for the significant fisheries receptors (impact factor) are contained in the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Biology (Gartner Lee Associates Limited, 1985a).

The potential link to human health effects and environmental impairment stems from the possibility of contaminants entering a watercourse as a result of a spill involving a vehicle transporting hazardous wastes. Should such an event occur and contaminants enter a watercourse, then sensitive water uses, e.g. municipal supply, and rural potable water supplies downstream from the spill could be at risk.

The likelihood of a transportation spill is considered to be low (Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Transportation, M. M. Dillon Limited 1985b). The likelihood of a transportation spill that would

result in a release of contaminants into a watercourse would be even lower. Finally, contingency plans will be in effect which would result in the notification of downstream users in the event that a spill does occur and waste enters the pathway. In such cases, water quality can be monitored and if proven to be contaminated, alternative water supplies could be provided. Nonetheless, a remote risk could still remain and the level of risk would vary among the siting options. The surface water study team concluded that routes still should be compared on the basis of the risk of accidental spillage to surface waters and the possible effects on downstream water uses.

Specifically, the factor selected for evaluating access route options was termed - transportation risk to surface waters. Two indicators were identified for this factor, namely:

1. the length of access route having a high risk of waste entry to a stream in the event of a transportation spill*, (hereinafter referred to as the stream crossing distance or SCD), and

2. stream length through lands with sensitive water use (hereinafter referred to as the Downstream Water Use Index or DSWUI).

.....

* In this discussion transportation spill is taken to mean either a transportation accident involving a vehicle that results in hazardous waste spillage, or an in-transit spill resulting from a loss of containment (container failure).

.....

A brief description of the factor and indicators is presented below. In addition, a factor sheet is contained in Appendix A. This sheet summarizes information concerning the factor and indicators including definitions, rationale, methodology, sources of information, study area, assumptions and data limitations.

2.3.2.2 Factor and indicator descriptions

The transportation risk to surface water factor takes into consideration the possibility of an accidental release of hazardous wastes to a watercourse during transit. The factor was designed to facilitate comparison of access road options and the selection of preferred routes. It incorporates consideration of both pathway and receptor components, i.e. SCD and DSWUI.

The SCD indicator provides a measure of the potential for waste entry into the surface water system in the event of a transportation spill (i.e. pathway). The methodology for derivation of the stream crossing distance is explained in detail in the companion surface water Technical Appendix. Basically, this distance represents a length of access road in the vicinity of a stream crossing where there is a high potential for wastes to enter a stream should a spill occur. It consists of two components:

(1) the length of access route within the top-of-bank flood-plain, where a spill would likely have direct access to a stream, and

(2) an adjacent, slightly sloping land segment where a spill would likely travel to a stream before an emergency response team could intercept it. In considering access road options, a minimum stream crossing distance is preferred along the local and regional access system.

The DSWUI indicator enables an evaluation of the significance a spill would have on downstream receptors, assuming it enters the stream. This indicator addresses the potential risk to human health through a consideration of sensitive water usage. Sensitive water uses were considered to be those that may involve water contact or consumption by humans, e.g. municipal water supplies, rural water takings for potable and/or domestic supply, and certain recreational uses such as swimming and camping.

Large consumers of stream water, such as municipal or communal water intakes were identified through agency contacts. It was not considered necessary for comparative evaluation purposes to interview residents along watercourses downstream from access road crossings to the point of discharge into one of the Great Lakes. An indication of "sensitive" water use in these areas was obtained by measuring the stream length passing through sensitive land uses such as rural, wooded and recreational land where a greater likelihood of interference with sensitive uses was assumed. This information provided the basis for the interpretation of a constraint rating for human health risk. Details on the methods used to measure this indicator are contained in the companion Technical Appendix.

2.3.3 DATA COLLECTION AND ANALYSIS

Information used in the Phase 4A evaluation of access route alternatives was obtained from 1:25,000 topographic maps, agency contacts and work completed during earlier OWMC phases. Access road options were identified by the M. M. Dillon Limited Transportation consultants.

Access road options were marked on 1:25,000 topographic maps and stream crossings were identified. Stream crossing distance along access routes was measured and/or calculated using the methods described in the companion surface water Technical Appendix.

The downstream study areas were also marked on 1:25,000 topographic maps. Rural, wooded and recreational land uses were identified from topographic maps and tne length of stream passing through these sensitive land uses was measured.

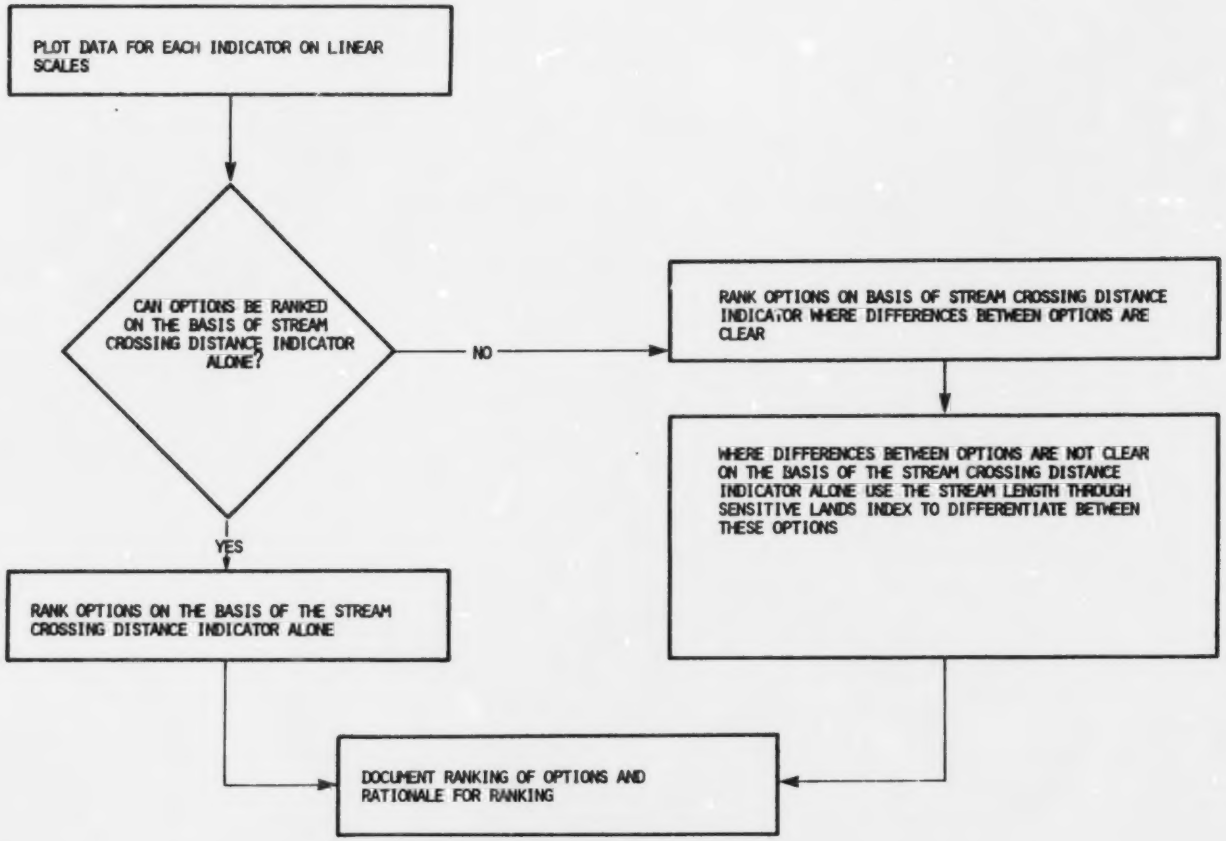
2.3.4 FACTOR APPLICATION

2.3.4.1 Evaluation process

The evaluation process for ranking access road options from a surface water perspective is shown in Figure 8. The first step in this process was to plot data for each option and for each indicator on a linear scale from zero to the maximum value for that indicator. These plots provided (for each indicator) a ranking of the options and also a measure of the relative differences among options.

For both the SCD and the DSWUI indicators, options lower on the scale are preferred to those higher on the scale.

FIGURE 8 EVALUATION PROCESS FOR RANKING ACCESS ROUTE OPTIONS


PLOT DATA FOR EACH INDICATOR ON LINEAR SCALES
CAN OPTIONS BE RANKED ON THE BASIS OF STREAM CROSSING DISTANCE INDICATOR ALONE?
NO
YES
RANK OPTIONS ON BASIS OF STREAM CROSSING DISTANCE INDICATOR WHERE DIFFERENCES BETWEEN OPTIONS ARE CLEAR
WHERE DIFFERENCES BETWEEN OPTIONS ARE NOT CLEAR ON THE BASIS OF THE STREAM CROSSING DISTANCE INDICATOR ALONE USE THE STREAM LENGTH THROUGH SENSITIVE LANDS INDEX TO DIFFERENTIATE BETWEEN THESE OPTIONS
RANK OPTIONS ON THE BASIS OF THE STREAM CROSSING DISTANCE INDICATOR ALONE
DOCUMENT RANKING OF OPTIONS AND RATIONALE FOR RANKING

Shorter stream crossing distances minimize the likelihood of waste entry to a stream from a transportation spill. Assuming spilled wastes actually enter a stream, a lower DSWUI as measured by stream distances through sensitive lands would minimize the risk to human health.

The second step in evaluating access road options was to aggregate (or combine) the indicator values to produce a single suitability rating that could be used to compare and rank the options. In this regard the SCD indicator was considered to be more important because it provided a measure of the potential for spilled wastes to enter a stream. The DSWUI indicator was considered to be slightly less important. This indicator provided only a surrogate measure of sensitive water usage. In the unlikely event of a spill, stream water quality could be monitored and if water supplies for human use were found to be contaminated then alternative supplies could be provided.

Following examination of the values of the two indicators for the various access route options and following initial attempts to combine indicators, it was apparent that all sets of options could be ranked solely on the basis of the SCD indicator.

2.3.4.2 Ranking of access route options

At the conclusion of the preliminary Phase 4A screening step, preferred access routes were identified for each of the facility siting options except LF-1E, LF-1E/PI-27E and LF-3C. The ranking of access road options for each of these remaining

siting options from the surface water perspective were determined using the previously described procedure. The listing of access route options, rankings and rationale are presented next for each siting option.

LF-1E

Four access route options were considered for the fully integrated siting option LF-1E (see Figure 9). The options considered follow:

1.* From QEW - west on Regional Road 47 (Lyons Creek Road/ Biggar Road); south on Regional Road 98 (Montrose Road); west on Carl Road to LF-1E.

3. From QEW - west on Regional Road 47 (Lyons Creek Road/ Biggar Road); south on Crowland Road to LF-1E.

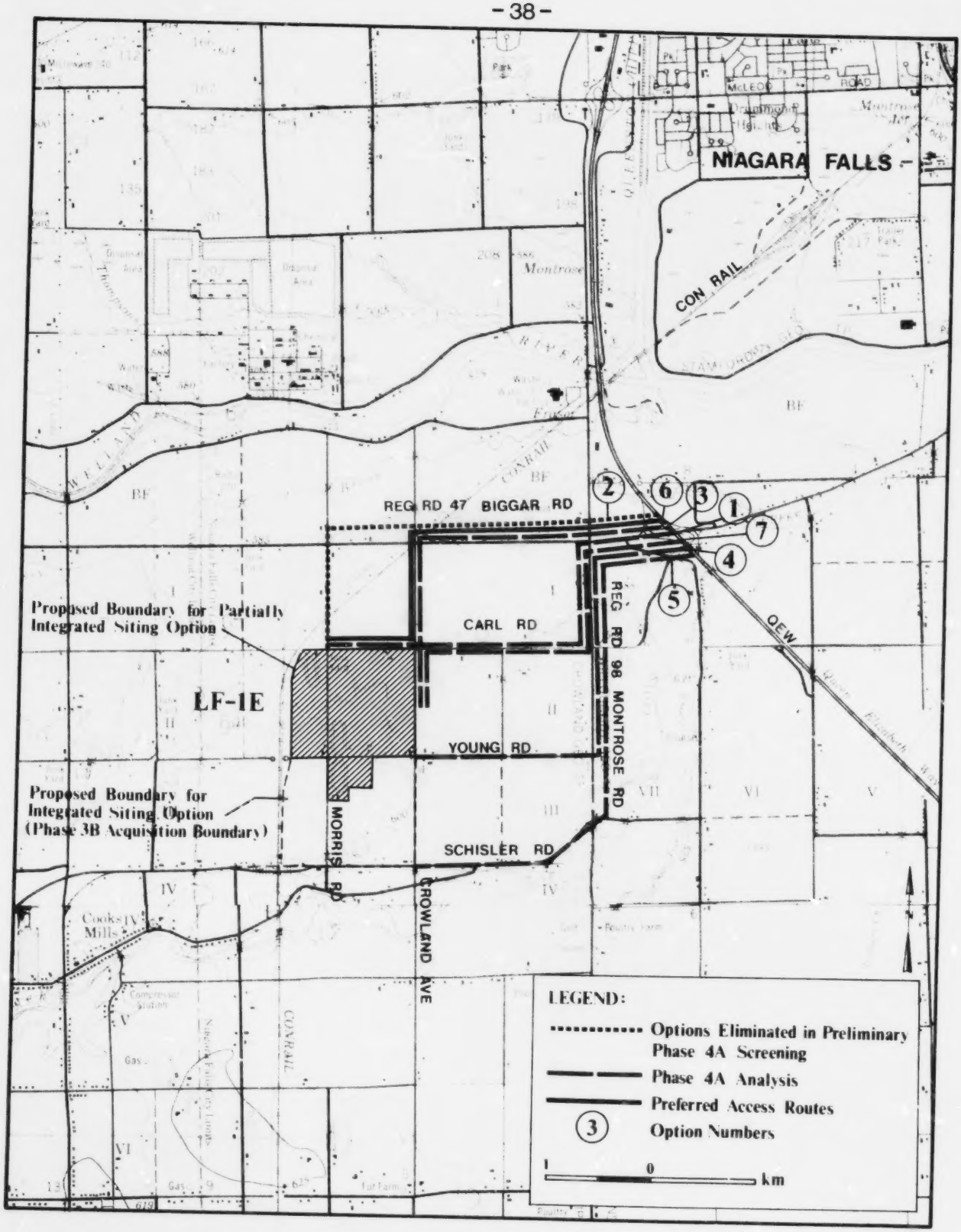
6. From QEW - west on Regional Road 47 (Lyons Creek Road/ Biggar Road); south on Crowland Road; west on Carl Road to LF-1E.

7. From QEW - west on Regional Road 47 (Lyons Creek Road/ Biggar Road); south on Montrose Road; west on Carl Road; south on Crowland Road to LF-1E.

.....

* Option numbers refer to the numbers in Figure 9. Option 2 was removed from consideration during the Phase 4A - preliminary analysis step. Options 4 and 5 were eliminated as a result of site boundary refinement.

.....



LF-1E

PHASE 4A ACCESS ROADS

FIGURE 9

As discussed earlier the first step in the evaluation process used to rank access route options was to plot data values for each indicator and option (see Figure 10 and Table 5). On the basis of the stream crossing distance indicator the following ranking of options was developed.

Option 6 - Most Preferred
3 -
1 -
7 - Least Preferred

TABLE 5 DATA MATRIX FOR LF-1E ACCESS ROUTE OPTIONS

OPTION #	STREAM CROSSING DISTANCE (m)	DOWNSTREAM WATER USE INDEX
1	380	22
3	100	10
6	0	0
7	480	35

A clear ranking of options was apparent on the basis of the SCD indicator. The DSWUI indicator reinforced the above ranking. The rationale for the ranking of the LF-1E access road options is presented in Table 6.

A detailed comparative evaluation of the LF-1E access road options was undertaken by the site selection team. Based on consideration of factors from all disciplines, Option 6 was identified as the preferred access road for site LF-1E integrated (M.M. Dillon Limited, 1985a).

FIGURE 10 RANKING OF ACCESS ROUTE OPTIONS BY SURFACE WATER INDICATORS: LF-1E

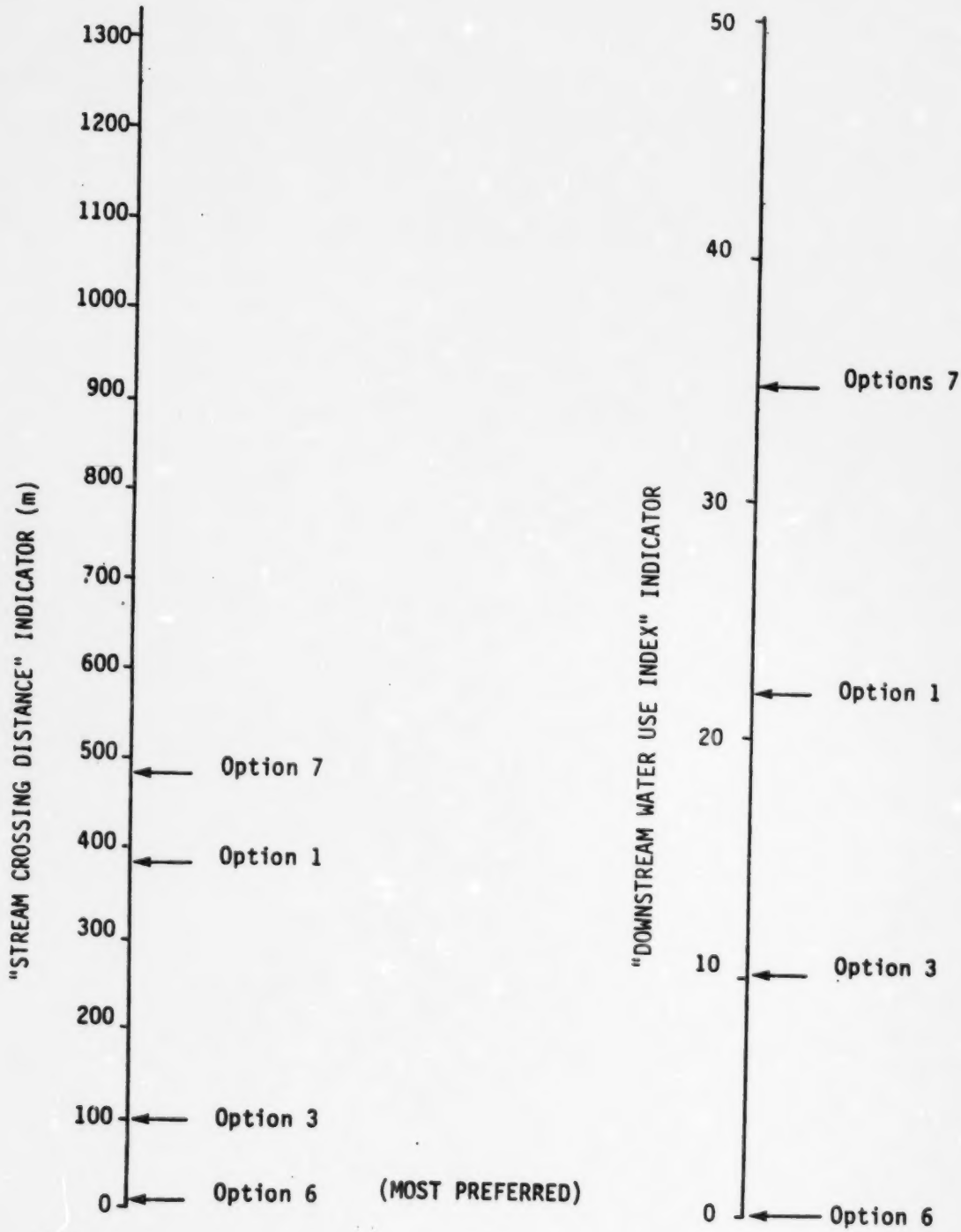


TABLE 6 RATIONALE FOR RANKING OF ACCESS ROUTE OPTIONS TO LF-1E

RANK	OPTION NO.	RATIONALE
MOST PREFERRED	6	• no constraints - no streams crossed
	3	• very minor constraints - stream crossing distance is 2nd lowest of all options - access route is identical to Option 6 except for extension where minor stream crossing occurs on Crowland Ave., south of Carl Road
	1	• minor constraint - stream crossing distance is 3rd highest of all options
	7	• minor constraint - stream crossing distance is highest of all options - access route is similar to Option 1 except additional minor stream crossing on Crowland Ave., south of Carl Road
LEAST PREFERRED		

NOTE: Constraint levels are relative for this set of options.

LF-1E/PI-27E

Two access route options (to the facility at P1-27E) were considered for the partially integrated siting option (see Figure 11). The options considered were:

1. from QEW; west on Regional Road 47 (Lyons Creek Road/Biggar Road) to PI-27E, and

2. from QEW; west on Regional Road 47; north on Regional Road 98 to PI-27E.

Neither of these options involved stream crossings, therefore, the SCD and the DSWUI indicators were zero for both options. Both options are equally preferred.

In addition to the above options, six access route alternatives were considered for the inter-site transport of material between LF-1E and PI-27E (see Figure 12). These options are listed below.

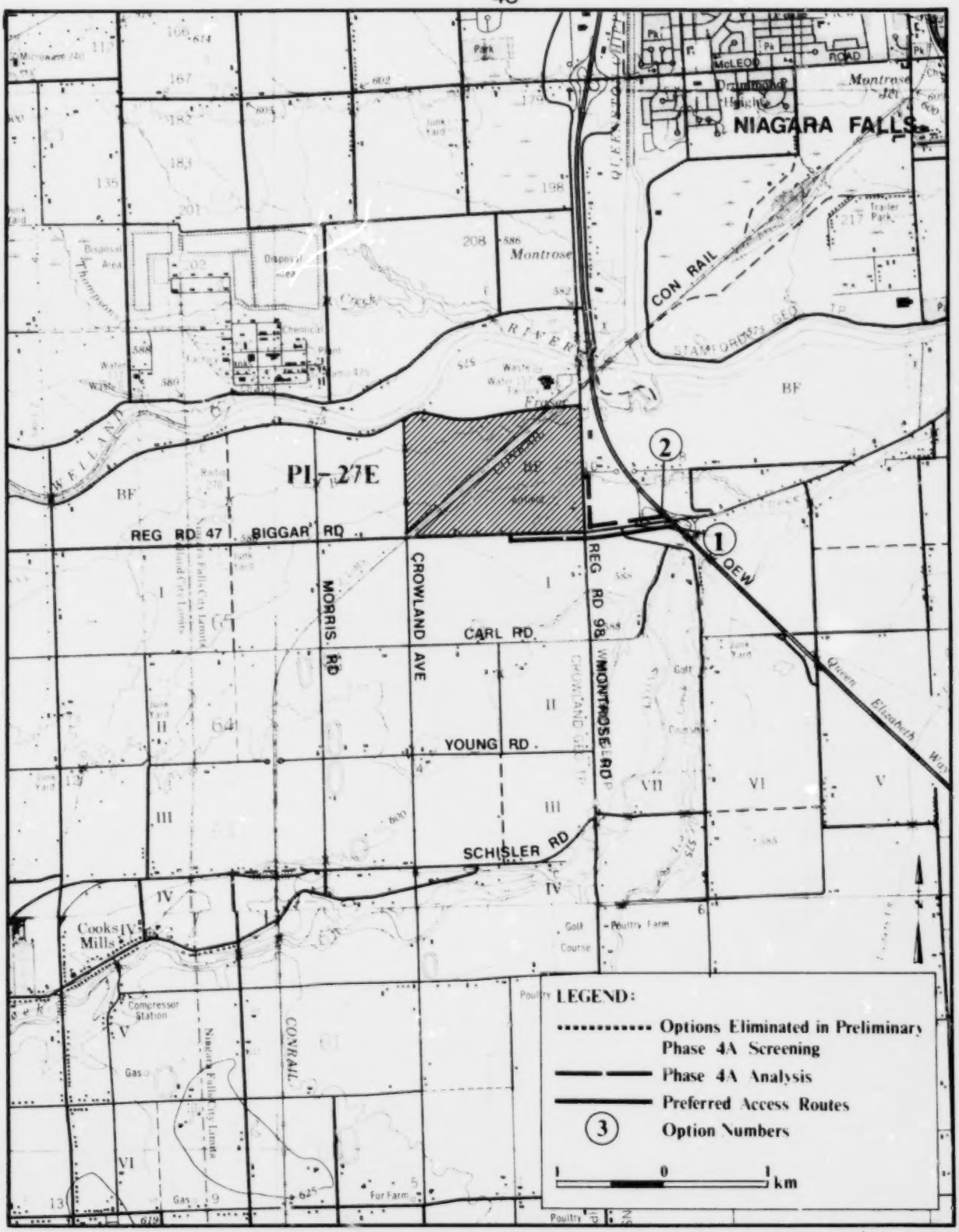
1.* From PI-27E - east on Biggar Road; south on Regional Road 98 (Montrose Road); west on Carl Road to LF-1E,

3. From PI-27E - west on Biggar Road; south on Crowland Road to LF-1E,

.....

* Option 2 was removed from consideration during the Phase 4A preliminary analysis step. Options 4 and 5 were eliminated as a result of site boundary refinement.

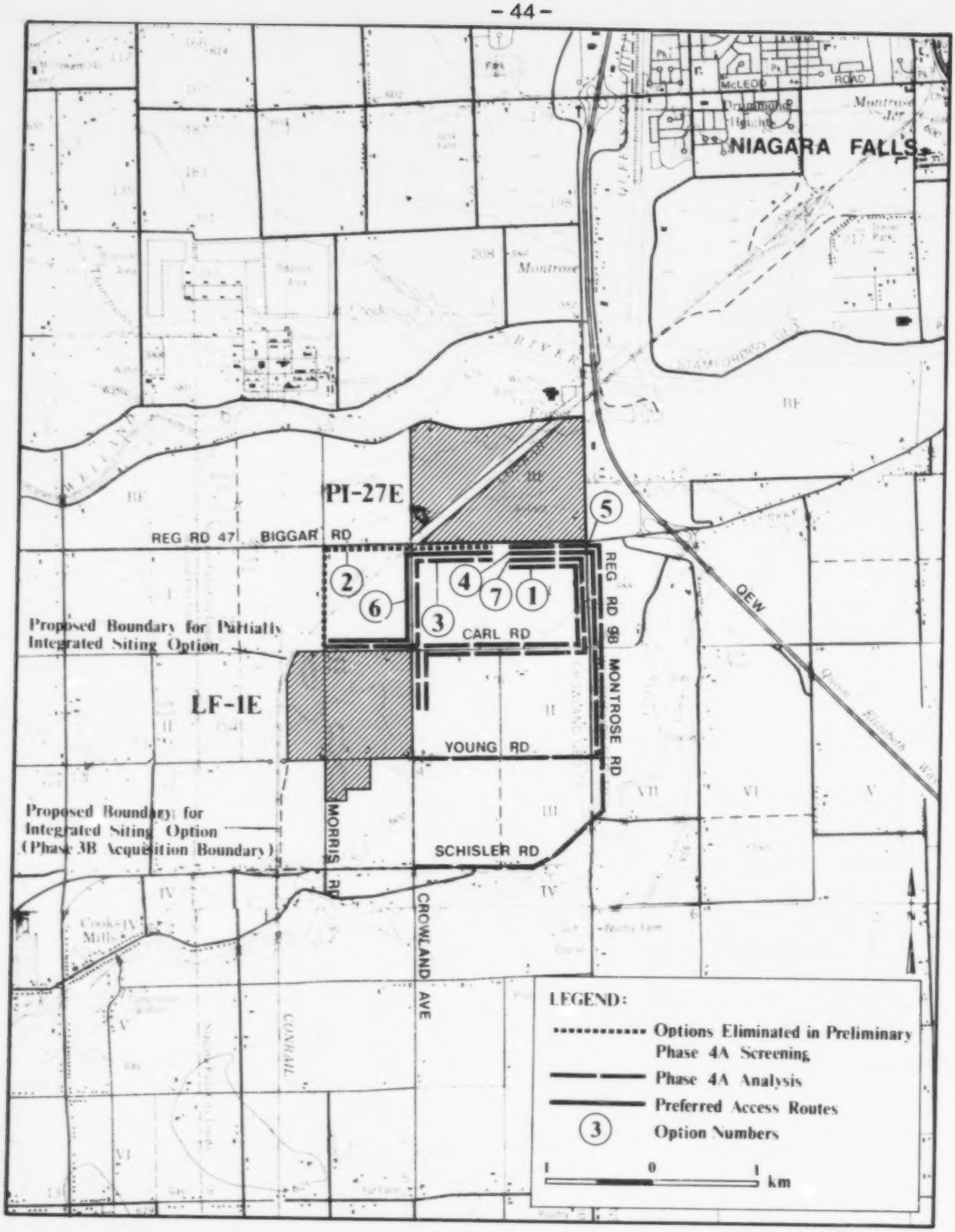
.....



LF-1E /PI-27E TO PI-27E

PHASE 4A ACCESS ROADS

FIGURE 11



LF-1E/ PI-27E
PI - 27E TO LF - 1E
PHASE 4A ACCESS ROADS

FIGURE 12

6. From PI-27E - west on Biggar Road; south on Crowland Road, west on Carl Road to LF-1E.

7. From PI-27E - east on Biggar Road; south on Montrose Road; west on Carl Road; south on Crowland Road to LF-1E.

From a surface water perspective, the ranking of these four options and the rationale for the ranking were identical to the options discussed for LF-1E integrated. The site selection team identified Option 1 as the preferred route to PI-27E (QEW - west on Biggar Road to PI-27E) and Option 6 as the preferred route between PI-27E and LF-1E.

LF-3C

Two access route options were considered for the fully integrated siting option LF-3C (see Figure 13). The options were:

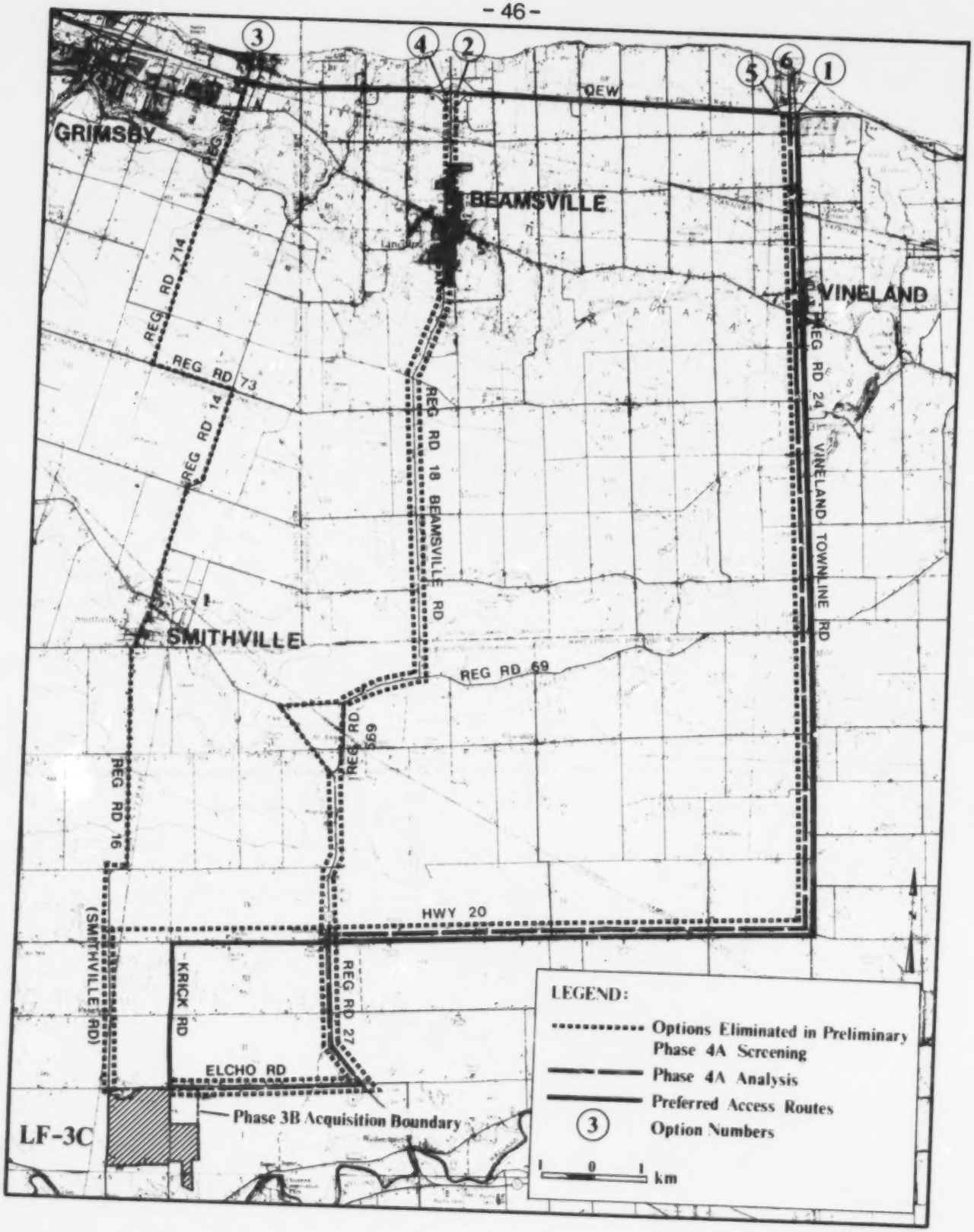
1.* from QEW - south on Vineland Townline Road (Regional Road 24); west on Highway 20; south on Regional Road 27; west on Elcho Road to LF-3C, and

6. from QEW - south on Vineland Townline Road (Regional Road 24); west on Highway 20; west on Regional Road 65 from Bismarck; south on Krick Road to LF-3C.

.....

* Options 2, 3, 4 and 5 were removed from consideration during the Phase 4A - preliminary analysis step.

.....



LF-3C

PHASE 4A ACCESS ROADS

FIGURE 13

The value of the two indicators for the LF-3C access route options are contained in Table 7 and plotted in Figure 14. On the basis of the stream crossing distance indicator (and supported by the water use index indicator), Option 1 was slightly preferred.

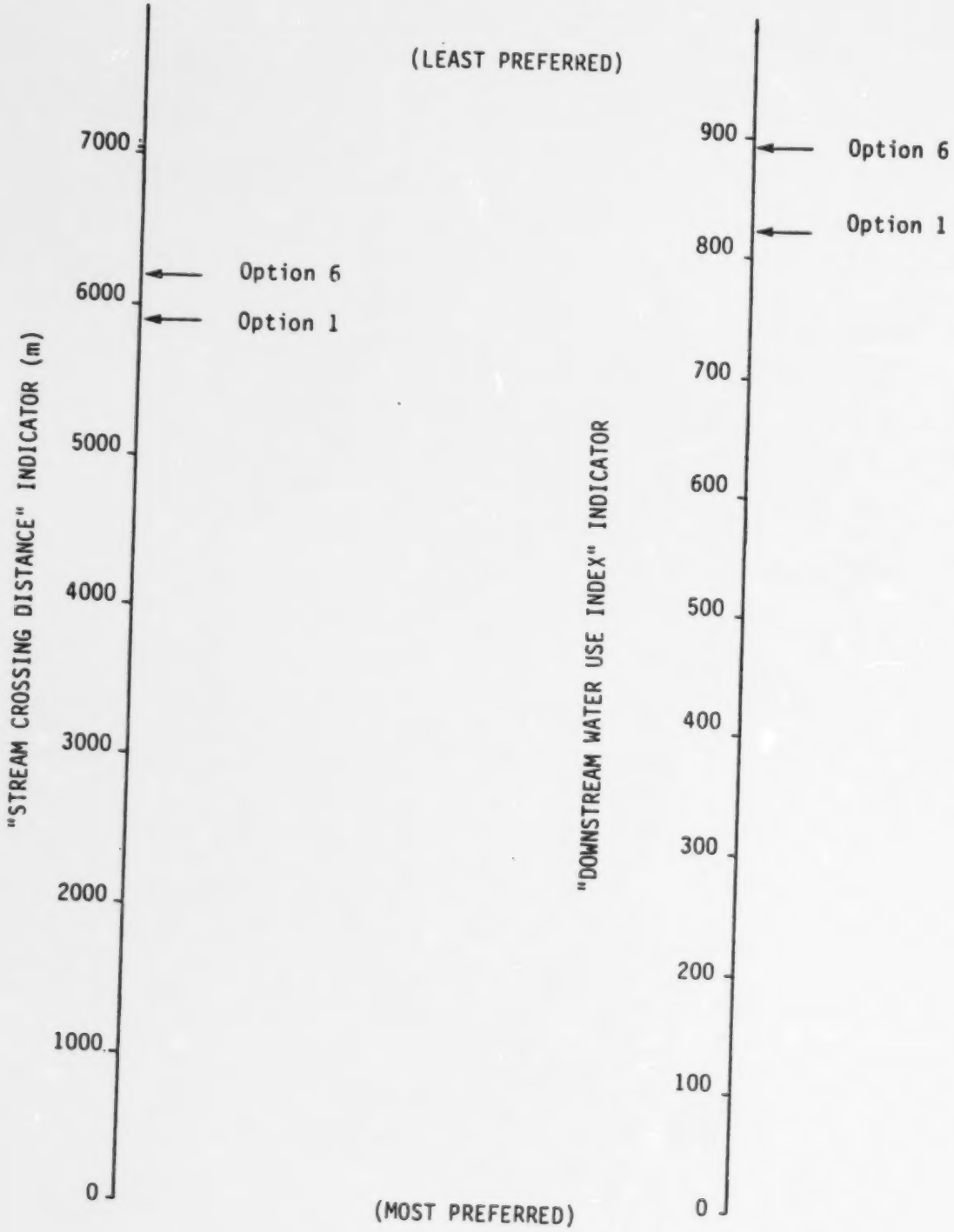
Options 1 and 6 are identical from the QEW - south on Vineland Road; west on Highway 20 to Regional Road 27 at Bismarck. Between Bismarck and LF-3C, Option 1 (Regional Road 27 - Elcho Road) has a smaller stream crossing distance and downstream water use index. The difference between the two options with respect to stream crossing distance is less than 5%.

The site selection team identified Option 6 as the preferred access route to LF-3C.

TABLE 7 DATA MATRIX FOR LF-3C ACCESS ROUTE OPTIONS

OPTION #	STREAM CROSSING DISTANCE (m)	WATER USE INDEX
1	5,945	823
6	6,205	895

FIGURE 14 RANKING OF ACCESS ROUTE OPTIONS BY SURFACE WATER INDICATORS: LF-3C



2.4 RAIL ACCESS OPTIONS

2.4.1 INTRODUCTION

The provision of rail access to a candidate site was viewed as an opportunity rather than as an absolute requirement. The major benefit associated with the bulk haulage of process additives and reagents by rail would be a reduction in both road transport haulage and in the cost of transport of these materials to an integrated or partially integrated site.

The purpose of this section is to describe the procedure used to evaluate rail access options to the candidate sites from the surface water perspective. This exercise resulted in recommendations for preferred rail access routes. The study area for this analysis consisted of broad corridors from the closest main rail line to the site boundary. In most cases the study area was entirely within the site vicinity. In the case of PI-13N major rail lines were more remote from the site, therefore a regional study area was included as well.

Two steps were involved in the overall assessment of rail access options. These steps were:

1. constraint mapping, and
2. comparative evaluation.

During the constraint mapping stage surface water factors as well as those from other disciplines, were noted in the assessment of broad transportation corridors. These corridors were identified by the M. M. Dillon Limited Transportation consultant and are described in M. M. Dillon Limited (1985b). The outcome of the constraint mapping

exercise was the identification of constraints affecting the location of rail access and the identification of specific rail access alignment options for further consideration.

The comparative evaluation step involved the assessment of the rail alignment options identified during the constraint mapping exercise and the selection of a preferred rail access route for the various facility siting options.

2.4.2 CONSTRAINT MAPPING

Surface water input to constraint mapping was based on the "number of stream crossings" factor (see Appendix A for the factor sheet).

The selection of the surface water factor was based on OWMC's site selection goals discussed earlier. Operation of a rail line carrying additives and reagents could result in an accident and environmental damage to surface water resources. It was therefore desirable to choose rail alignments that avoided or minimized the number of stream crossings.

The rail access constraint mapping step involved the preparation of 1:10,000 scale constraint maps, showing streams and flood-prone areas. This information was prepared on overlays and provided to the M .M. Dillon Limited site selection consultants. Copies of these workings maps are on file with GLAL. The data for these analysis were derived from existing site and site vicinity investigations.

Corridors provided by the transportation consultant (M. M. Dillon Limited 1985b) extended from the existing main

rail line corridor to the acquisition limit of the candidate sites. The number of stream crossings was determined by overlaying the surface water constraint map onto the rail access corridors map. Stream crossings were counted and major floodplains, flood-prone areas, and wetland areas noted. The surface water data were used, along with data provided by other disciplines, to highlight specific constraints and identify rail access options that warranted examination in more detail.

Table 8 provides a description of the surface water features within each study corridor. Using the information summarized in this table, the surface water team participated in a constraint mapping exercise which identified a number of options for rail access to some of the facility siting options. No rail options were identified through the constraint mapping analysis for sites PI-13N and LF-2N because of a number of major constraints that had been identified by the site selection team. An existing ConRail line ran diagonally through PI-27E and therefore there were no off-site impacts for this site. This process is documented in the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection (M. M. Dillon Limited, 1985a).

2.4.3 COMPARATIVE EVALUATION OF RAIL OPTIONS

2.4.3.1 Introduction

As described in the previous section, the site selection team identified rail access options through a contraint mapping exercise. Reasons for the selected options are detailed in the overall site selection report (M.M. Dillon 1985a).

TABLE 8 SUMMARY OF SURFACE WATER FEATURES - CONSTRAINT MAPPING STAGE FOR RAIL ACCESS OPTIONS

SITE	NUMBER OF STREAMS CROSSED*	COMMENTS
LF-2N to the west	6-7 stream crossings (2 major)	- major crossing of Credit River and flood plain - flood plain crossing of Fletcher's Creek
PI-13N	4-7 stream crossings (3 major)	- flood prone areas along Sixteen Mile Creek
PI-1N	0-1 minor stream crossing	- no flood plains - no wetlands - preference to avoid south
LF-4N	1-2 minor stream crossings	- no flood plains - no wetlands
LF-3C	0-1 minor stream crossings	- no flood plains - no wetlands
LF-9C North	1-3 minor stream crossings	- 5 small wetland areas crossed - preferred to east option
LF-9C East	2-4 stream crossings (1 major)	- 1 flood-prone area crossed - 8 small wetland areas crossed
LF-1E North	0-1 minor stream crossing	- no flood plains - no wetlands
LF-1E West	MAIN RAIL LINE WITHIN SITE BOUNDARIES	
PI-27E	MAIN RAIL LINE WITHIN SITE BOUNDARIES	

* Depends on selected alignment within study area.

2.4.3.2 Factor identification

Two surface water factors were identified as follows:

1. the number of stream crossings, and
2. the proximity to floodplains and flood-prone areas.

These factors (see Appendix A for factor sheets) were used to compare alternative rail alignments and identify preferred routes. As stated previously, operation of a rail line carrying additives and reagents to a waste treatment facility may result in environmental damage should a transportation accident occur. In consideration of OWMC's stated site selection goals of minimizing impact on the environment, it is desirable to choose rail alignments that avoid or minimize the number of stream crossings and hence reduce the possibility of environmental damage to surface water.

The "number of stream crossings" factor is a measure of the extent of surface water resources potentially exposed to environmental damage should a rail accident occur, e.g. damage directly to the watercourse. The proximity to floodplains and flood-prone areas factor provides a measure of the extent of potential surface water resources -- other than watercourses themselves -- at potential risk, e.g. floodplains and wetlands. In ranking alignment alternatives, preference was given to options which minimized watercourse crossings and avoided flood-prone and wetland areas.

2.4.3.3. Data collection and analysis

The comparative evaluation of rail options into each site was conducted at a scale of 1:10,000. Stream crossing and

flood-prone area data were available from the surface water overlays used in the constraint mapping stage. The methods used to delineate floodplains and flood-prone areas are outlined in the companion Technical Appendix of this report.

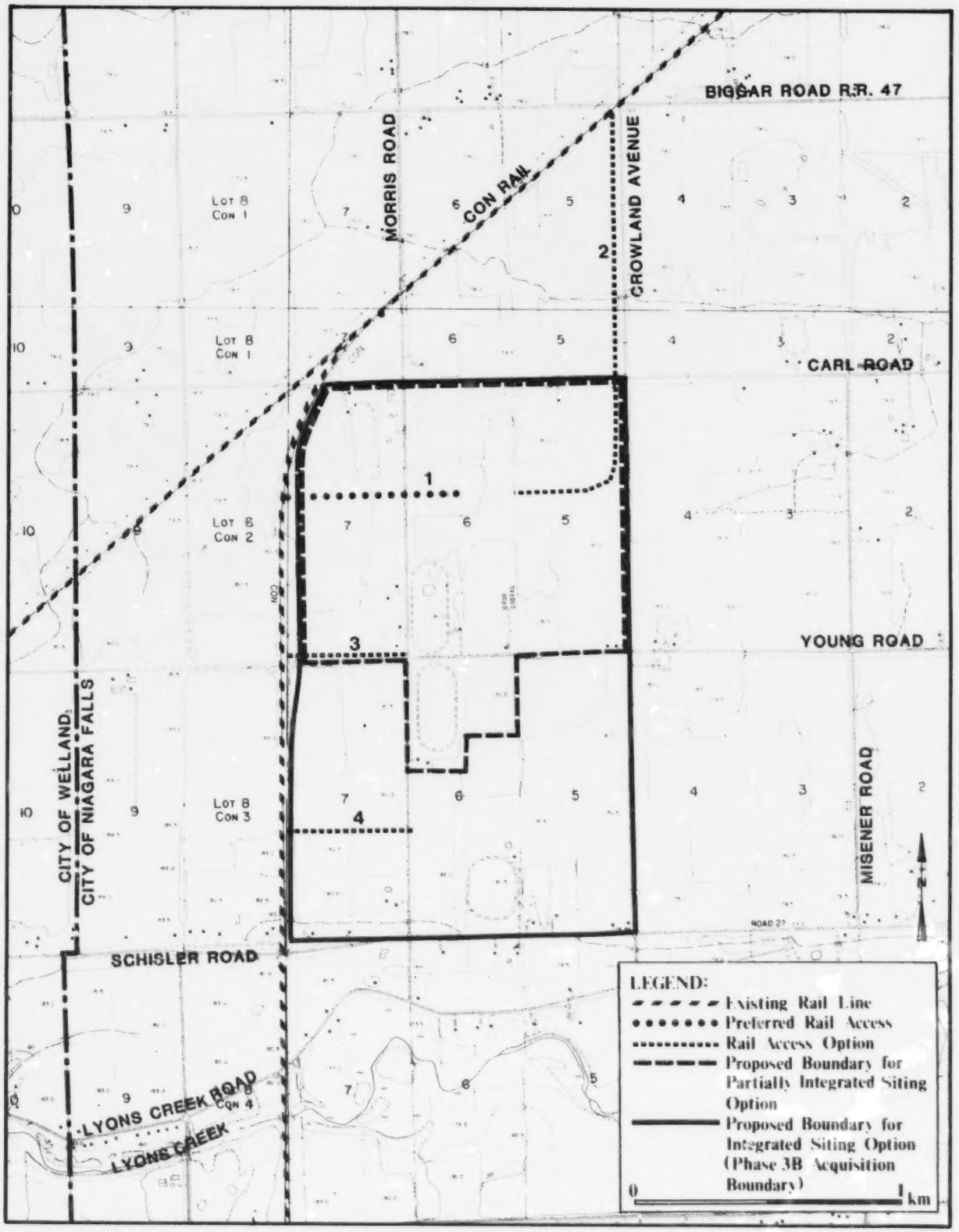
2.4.3.4 Factor application

As described previously,the constraint mapping exercise undertaken by the site selection team identified a number of rail access options for the following sites: LF-1E, LF-3C, LF-9C, LF-4N and PI-1N. Rail access options are shown in figures 15 to 19.

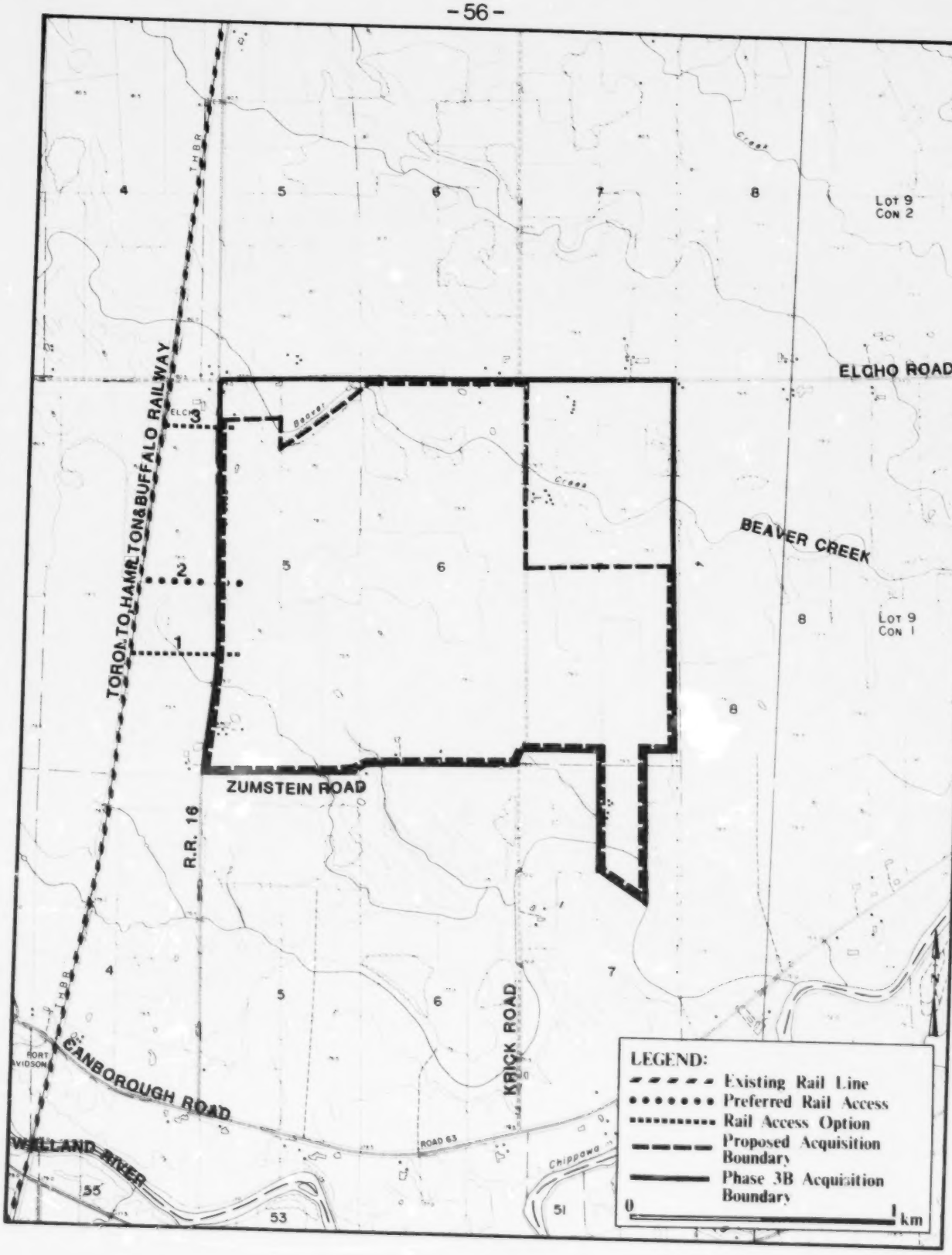
To develop a ranking of rail alignment alternatives for each site it was necessary to combine the two surface water factors. In the combining process the stream crossing and flood-prone area factors were considered to be of equal importance.

Stream crossings, floodplains and wetlands each represent a surface water feature that must be crossed by the proposed rail service. Therefore, each feature would require construction activity that could potentially affect the environment, e.g. bridges, culverts and road bed elevation. Similarly, each of these surface water features represent a resource that could be damaged in the unlikely event of a rail accident.

The number of stream crossings, floodplains and wetlands were thus added and the sum was then used to rank the rail alignment alternatives. This information is summarized and a ranking of options provided in tables 9 to 13. The rationale for the rankings is presented in Table 14.

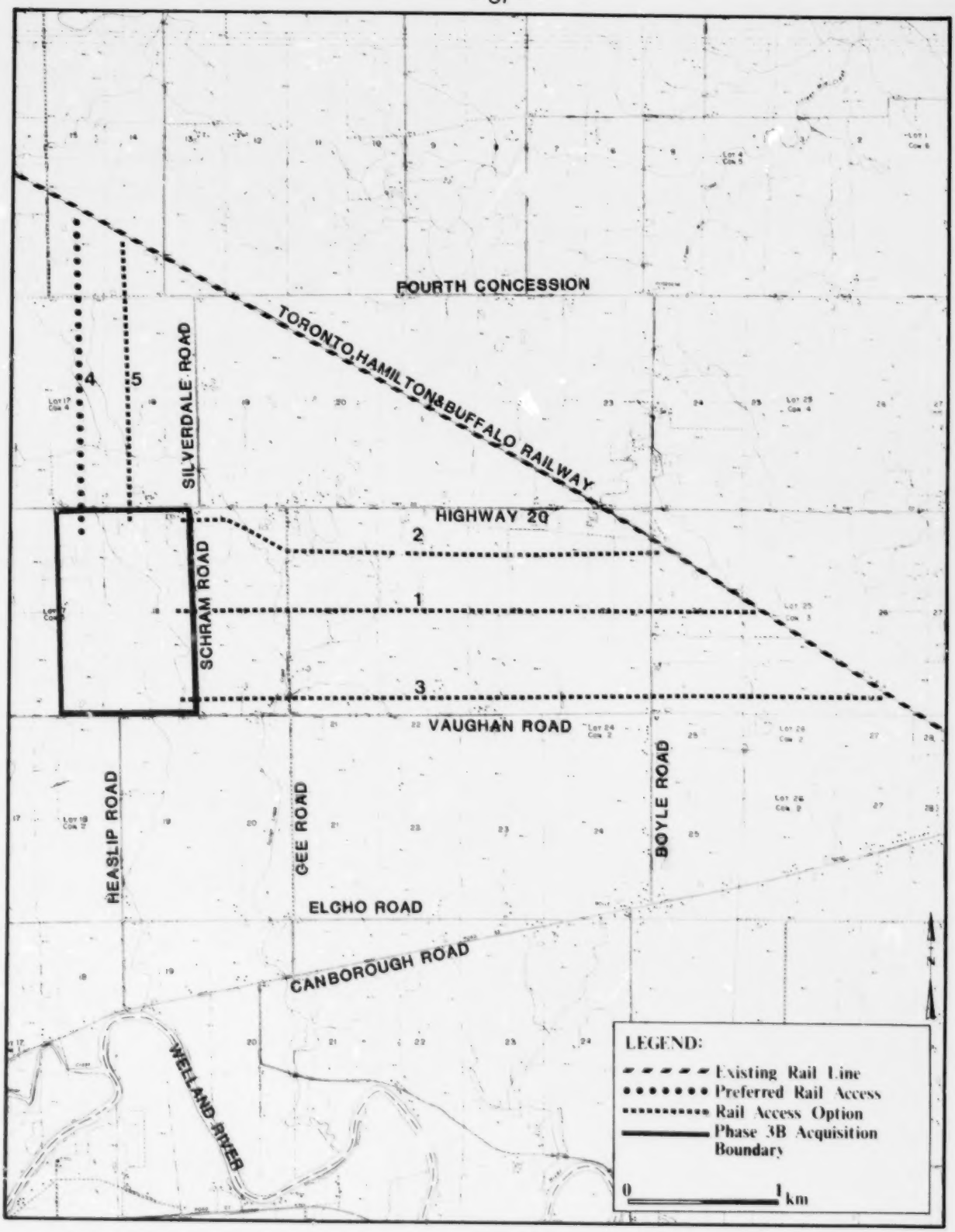


LF-1E
RAIL ACCESS
FIGURE 15

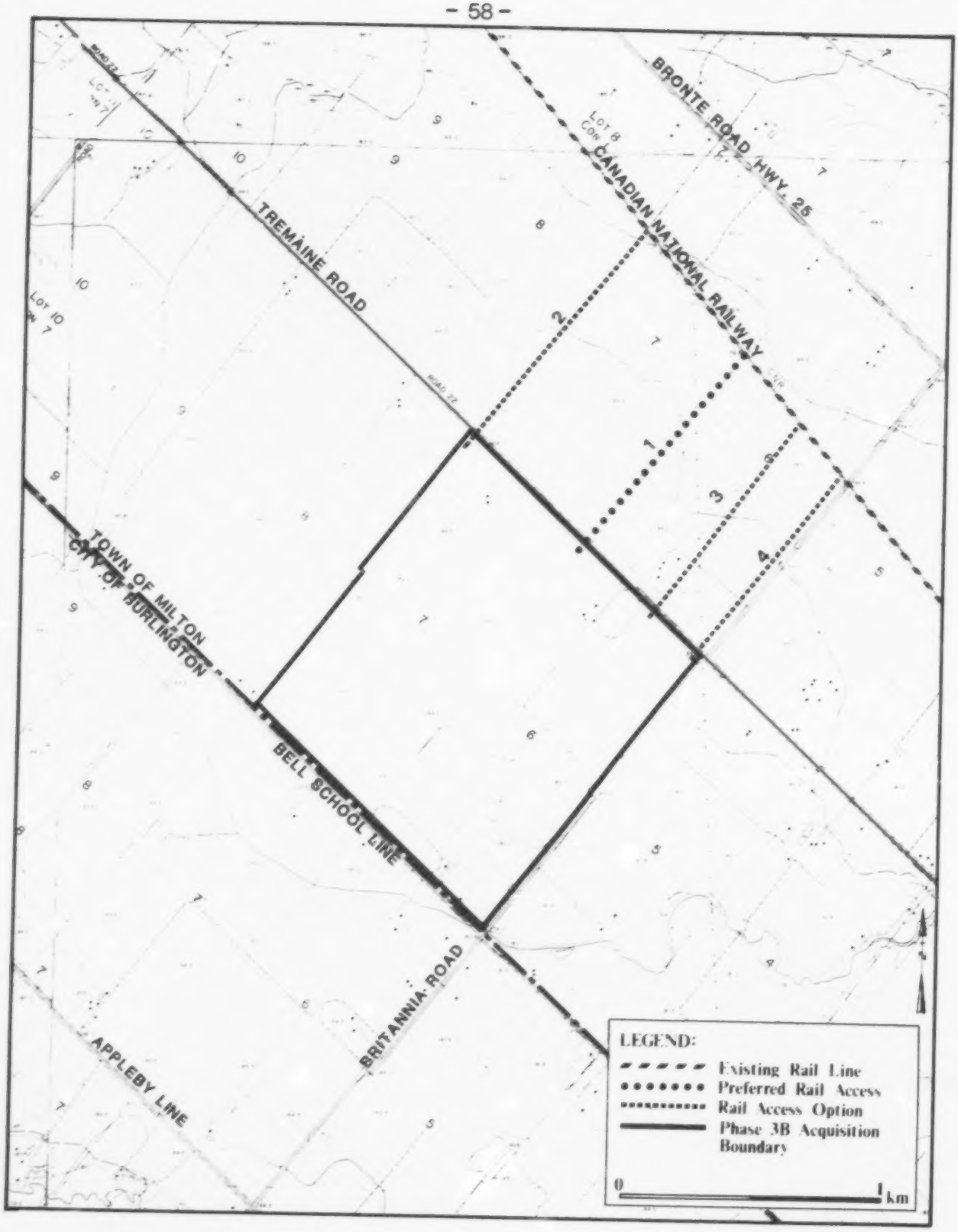


LF-3C
RAIL ACCESS

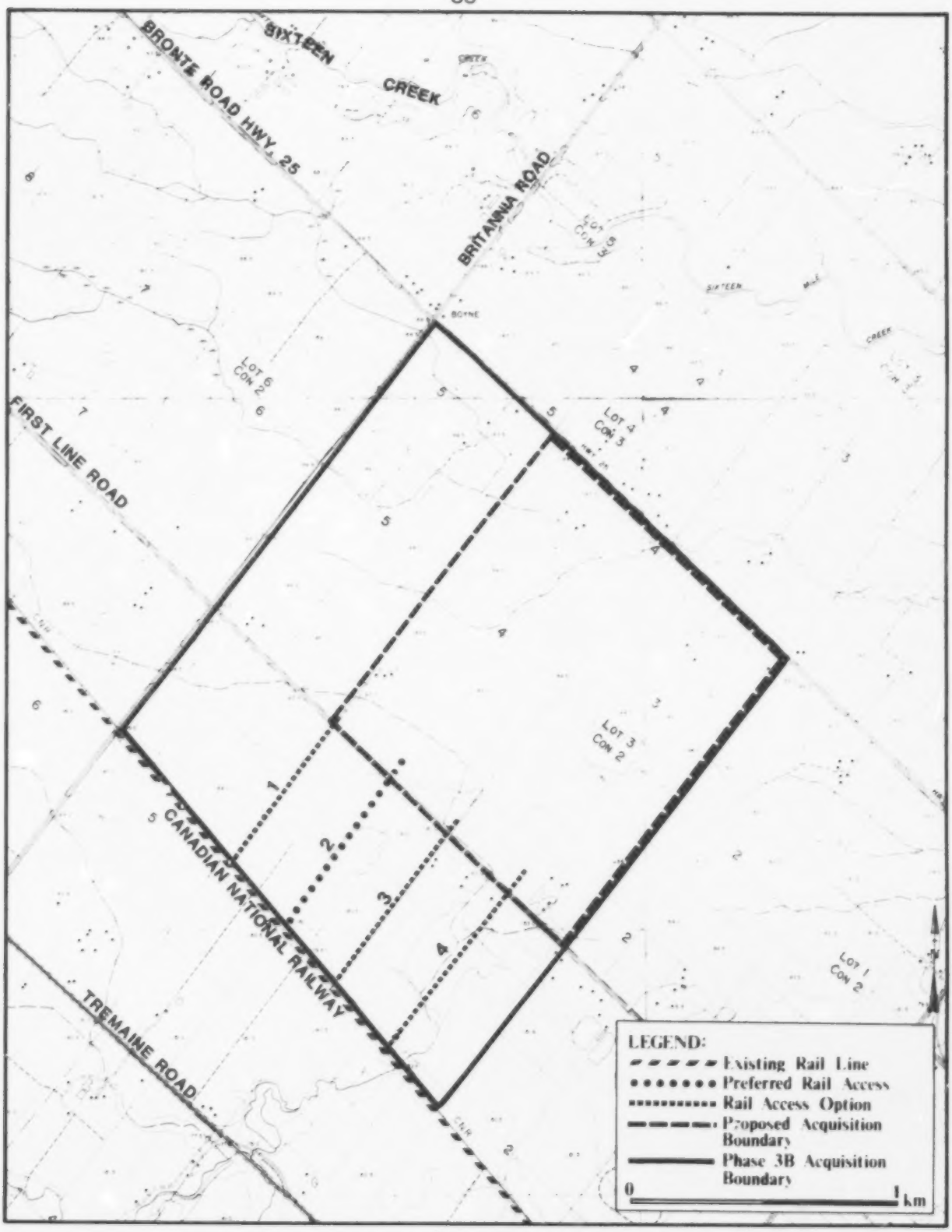
FIGURE 16



LF-9C
RAIL ACCESS
FIGURE 17



LF-4N
RAIL ACCESS
FIGURE 18



PI-1N
RAIL ACCESS

FIGURE 10

TABLE 9 COMPARATIVE EVALUATION OF RAIL ALIGNMENT ALTERNATIVES FOR SITE LF-1E

FACTORS	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Number of streams crossed	N/A	1	0	N/A
Number of flood plains, flood-prone areas, and wetlands	N/A	0	0	N/A
Total	N/A	1	0	N/A
Option Ranking	N/A	2	1	N/A

TABLE 10 COMPARATIVE EVALUATION OF RAIL ALIGNMENT ALTERNATIVES FOR SITE LF-3C

FACTORS	OPTION 1	OPTION 2	OPTION 3
Number of streams crossed	1	0	0
Number of flood plains, flood-prone areas, and wetlands	0	0	0
Total	1	0	0
Option Ranking	2	1	1

TABLE 11 COMPARATIVE EVALUATION OF RAIL ALIGNMENT ALTERNATIVES FOR SITE LF-9C

FACTORS	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Number of streams crossed	4	2	3	2	3
Number of flood plains, flood-prone areas, and wetlands	6	2	1	4	4
Total	10	4	4	6	7
Option Ranking	4	1	1	2	3

TABLE 12 COMPARATIVE EVALUATION OF RAIL ALIGNMENT ALTERNATIVES FOR SITE LF-4N

FACTORS	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Number of streams crossed	2	2	1	1
Number of flood plains, flood-prone areas, and wetlands	0	0	0	0
Total	2	2	1	1
Option Ranking	2	2	1	1

TABLE 13 COMPARATIVE EVALUATION OF RAIL ALIGNMENT ALTERNATIVES FOR SITE PI-1N

FACTORS	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Number of streams crossed	2	0	0	1
Number of flood plains, flood-prone areas, and wetlands	0	0	0	1
Total	2	0	0	2
Option Ranking	2	1	1	2

TABLE 14 RATIONALE FOR RANKING RAIL ACCESS OPTIONS

LF-1E (Table 9)

- Options 1 and 4 fall within the site acquisition limits. Since they create no "off-site" impacts (i.e. cross no surface water features) they are considered to be equal, preferred options.

- Options 2 and 3 each have one minor stream crossing. These options are considered to be equal and slightly less preferred over options 1 and 4.

LF-3C (Table 10)

- Options 2 and 3 have no constraints and are thus considered to be equal, preferred options.

- Option 1 has a minor stream crossing which is considered to be a minor (low) constraint and is therefore slightly less preferred.

(Continued)

TABLE 14 RATIONALE FOR RANKING RAIL ACCESS OPTIONS (continued)

LF-9C (Table 11)

- Options 2 and 3 are considered to be the preferred options. Each option involves the least number of surface water features crossed (4). No floodplains are crossed; however, a few small flood-prone areas and wetland areas are crossed. These options are considered to have a low constraint for the surface water factor and are considered to be equal.

- Option 4 is the next preferred option. It has two minor stream crossings and four small wetland crossings, i.e. six surface water features crossed.

  Option 4 is slightly preferred over Option 5 because it crosses one less surface water feature.

- Option 1 is the least preferred option. It has four channel crossings and six wetland crossings, i.e., 10 surface water features crossed.

LF-4N (Table 12)

- The number of floodplains, flood-prone areas and wetlands factor does not occur for any of the rail alignment options and is therefore not a consideration in selection of preferred options.

- Options 3 and 4 are considered to be the preferred options as they each have only one minor stream crossing. There is no difference between these options.

- Options 1 and 2 are slightly less preferred to Options 3 and 4 due to the occurrence of one additional minor stream crossing. Options 1 and 2 are considered to be equal.

PI-1N (Table 13)

- Options 2 and 3 have no surface water features crossed and are thus preferred options.

- Options 1 and 4 are slightly less preferred (one more surface water feature). Options 1 and 4 are considered to be equal from the surface water perspective.

2.5 LOCATION OF PHYSICAL/CHEMICAL TREATMENT PLANT FOR PARTIALLY INTEGRATED SITING OPTIONS

2.5.1 INTRODUCTION

The purpose of this section is to describe the procedure used in the refinement of the siting option stage to locate the physical/chemical plant for the partially integrated options from a surface water perspective. This exercise resulted in the identification of a preference for facility arrangements on partially integrated siting options.

A partially integrated siting option refers to the location of the physical/chemical (phys/chem) plant in association with the landfill or the incineration plant.

Consequently, this entails two possible options:

- the phys/chem plant is associated with the incineration plant leaving the landfill to be located on a separate site; or

- the phys/chem plant is located with the landfill isolating the incineration plant on a separate site.

The various options which were considered are identified in Table 15. A schematic diagram showing the various types of movements is shown in Figure 20.

From a surface water perspective the differences between options were evaluated on the basis of the potential of contaminant entry to a receiving watercourse associated with accidental spillage along an access or inter-site transfer route.

TABLE 15 PARTIALLY INTEGRATED SITING OPTIONS - FACILITY ARRANGEMENT ALTERNATIVES

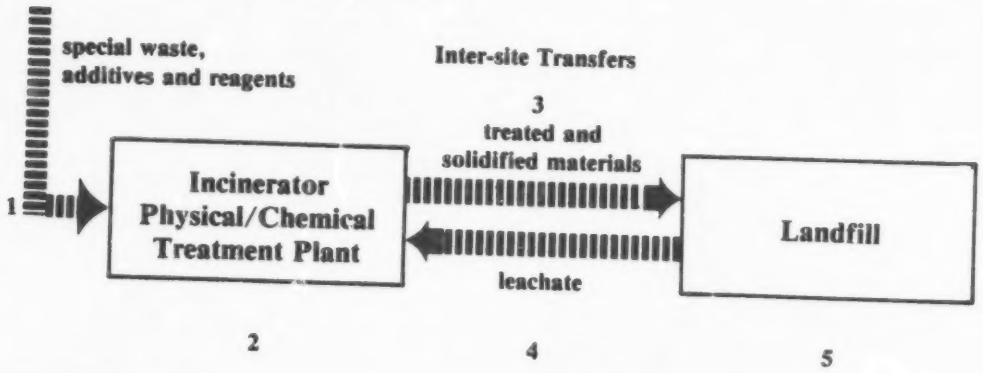
	OPTION 1: SEPARATE LANDFILL		OPTION 2: SEPARATE INCINERATOR	
	Inc/Phys/ Chem	Landfill	Landfill/Phys/ Chem	Incinerator
1.	PI-1N	LF-4N	LF-4N	PI-1N
2.	PI-13N	LF-4N	LF-4N	PI-13N
3.	PI-27E	LF-1E	LF-1E	PI-27E

Inc = Incineration Plant
Phys/Chem = Physical Chemical Treatment Plant

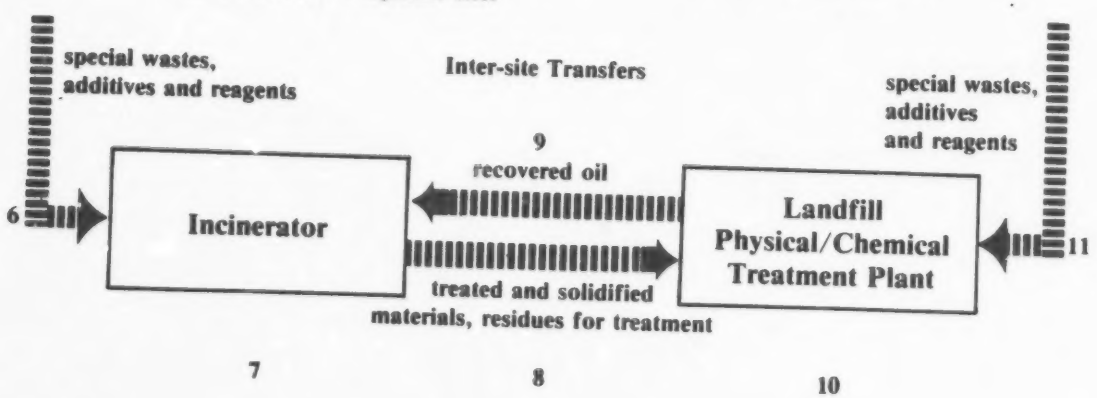
FIGURE 20

SCHEMATIC OF PARTIALLY INTEGRATED SITING OPTIONS

OPTION 1: The physical/chemical treatment plant with the incinerator and the landfill facility on a separate site.



OPTION 2: The physical/chemical treatment plant with the landfill facility and the incinerator on a separate site.



LEGEND

1 = access route for transporting - special waste, additives and reagents to the physical/chemical treatment plant
2 = site of the incinerator and the physical/chemical treatment plant
3 = inter-site transfer route for the treated and solidified materials from the incinerator and physical/chemical treatment plant to the landfill facility
4 = inter-site transfer of leachates from the landfill to the incinerator and physical/chemical treatment plant
5 = site of the landfill facility
6 = access route for transporting special wastes and reagents to the incinerator
7 = incinerator site
8 = inter-site transfer route for transporting treated and solidified materials and residues for treatment from the incinerator to the landfill facility
9 = transfer route for transporting recovered oil from the physical/chemical treatment plant to the incinerator
10 = site of the physical/chemical treatment plant and the landfill facility
11 = access route for transporting special waste, additives and reagents to the physical/chemical treatment plant.

2.5.2 FACTOR IDENTIFICATION

The identification of factors and indicators used in the detailed comparative evaluation of the partially integrated options was based on OWMC's site selection goals discussed earlier.

A "surface water suitability" factor was identified which takes into consideration the possibility of an accidental release of hazardous wastes, additives and reagents to a watercourse during transit. The factor was designed to facilitate comparison of partially integrated siting options on the basis of preferred access roads. The factor consists of one indicator, i.e. a spill pathway index, (SPI).

The SPI indicator provides a measure of the potential for spilled wastes to enter a watercourse. It pertains to local and regional access roads and combines data on the number of potential in transit vehicle spills, number of vehicles anticipated on local road sections and the proportion of the access road where spilled wastes are likely to enter watercourses.

2.5.3 DATA COLLECTION AND ANALYSIS

The hazard based spill index consists of spill frequency values and weighting factors. The hazard based spill index considers the type of waste being hauled, e.g., special wastes, additives and reagents and treated wastes. Spill frequency values which provided an estimate of the potential for a waste spill occurring along a particular access route were determined by the Transportation consultant (M.M. Dillon Limited, 1985b).

The proportion of the access route where spilled wastes are likely to enter watercourses consists of the ratio of stream crossing distance to access route length, for each link of the route. This measurement was provided by GLAL.

The stream crossing distance consists of two components -- the length of access route within the top-of-bank floodplain, where a spill would likely have direct access to a stream, and an adjacent slightly sloping land segment where a spill would likely travel to a stream before an emergency response team could intercept it. The stream crossing distance and the method used to derive it are explained in detail in the companion Technical Appendix.

The SPI was determined by multiplying the ratio of stream crossing distance to access route link length by the hazard based spill index, and summing over the entire route length. This calculation was performed by the M. M. Dillon Transportation consultant with input from GLAL. These values were then compared to determine a preferred option, (see Table 16).

2.5.4 FACTOR APPLICATION

SITING OPTION - (PI-1N/LF-4N) The separate landfill (Option 1) was preferred because of the shorter haul distance for special wastes. The number of stream crossings was reduced from 17 to 12 or approximately 30% under the separate landfill option. The SPI index for Option 1 was found to be approximately 31% lower than that determined for Option 2.

SITING OPTION - (PI-13N/LF-4N) In this case which is similar to siting option PI-1N/LF-4N, Option #1 (separate landfill) is

TABLE 16 SELECTION OF PREFERRED PARTIALLY INTEGRATED SITING OPTIONS

NO.	SITING OPTIONS	OPTION 1: SEPARATE LANDFILL		OPTION 2: SEPARATE INCINERATOR	
		SPILL PATHWAY INDEX	RANK *	SPILL PATHWAY INDEX	RANK *
1	PI-1N/LF-4N	0.721	1	1.043	2
2	PI-13N/LF-4N	0.579	1	1.023	2
3	PI-27E/LF-1E	0.000	1	0.000	1

* 1 = Preferred

preferred. The SPI for Option #1 was found to be about 43% lower than Option #2.

SITING OPTION - (PI-27E/LF-1E): Since neither option involved a significant stream crossing, surface water factors were not a consideration in the selection of a siting option.

The results of the site selection team's recommendations for facility arrangements on partially integrated siting options are documented in the overall site selection report (M.M. Dillon Limited, 1985a).

3.0 COMPARISON OF SITING OPTIONS

3.1 INTRODUCTION

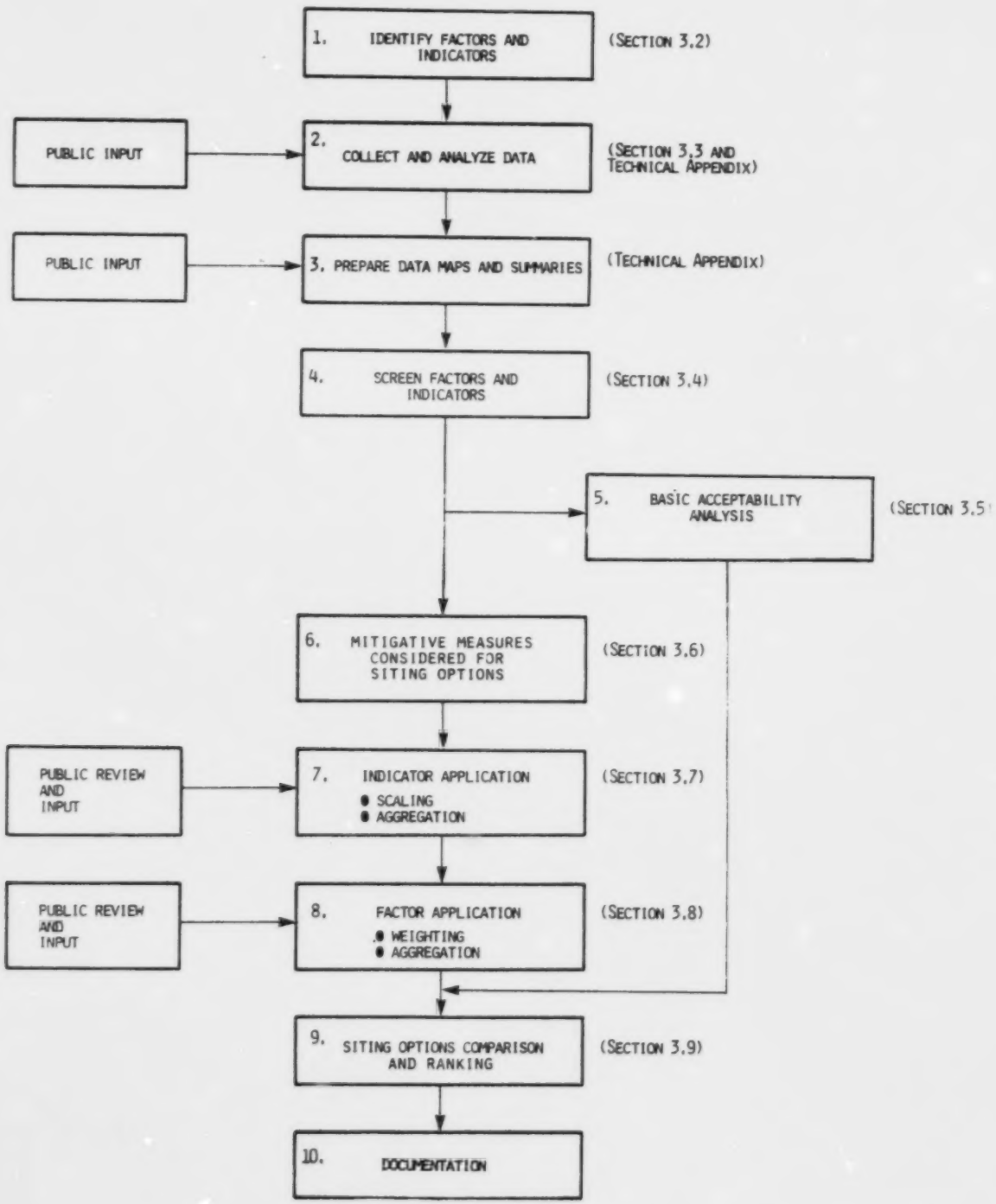
The purpose of this section is to describe the procedure used to evaluate facility sitings options from the surface water perspective. The outcome of this procedure was the ranking of the siting options and the documentation of the reasons for the ranking.

The ten steps in the evaluation procedure are depicted in Figure 21. A brief description of each step is presented below.

Step 1: The initial step in the evaluation process was the identification of factors and indicators. This occurred at the beginning of Phase 4A prior to data collection. The purpose of factor and indicator identification was to focus data collection efforts on important surface water issues relating to site selection. Factors and indicators were refined or modified as the data collection and analyses proceeded. Factor and indicator identification are discussed in more detail in Section 3.2.

Step 2: The second step involved the collection, compilation and analysis of data relating to the various surface water factors. Data collection included input from the public. Data collection and analysis methods are described briefly in Section 3.3 and in detail in the separate Technical Appendix.

FIGURE 21 STEPS IN EVALUATION OF FACILITY SITING OPTIONS SURFACE WATER



Step 3: At the conclusion of the data collection and analysis step, information relating to the various facility siting options was extracted from the Phase 4A data base and used to prepare maps and matrices. This information formed the basis for the detailed comparative evaluation of facility siting options and was made available to the public for review.

Step 4: The first task in combining information to undertake the comparative evaluation was the screening of factors and indicators. This step eliminated factors and indicators where:

(1) there was no difference among options,
(2) it was not possible to apply factors or indicators,
(3) indicators were considered negligible or insignificant, and
(4) "double counting" of information was occurring.

Step 5: In this step, siting options were examined to determine if they met basic acceptability requirements (e.g. avoidance of flood susceptible areas in the case of surface water). Where serious constraints (operational constraints) were identified special design measures were identified, e.g. modifying site layout to avoid flood-prone areas. The sites were then re-examined assuming that these measures would be applied. Should sites still fail to meet basic requirements at this point they were rejected from further consideration.

Step 6: During this step the preliminary facility design prepared by Monenco Ltd. was examined and modifications were recommended to minimize potential effects on surface waters. This included incorporation of surface drainage

improvements, upgrading of downstream channel capacity and modification of facility layout to avoid flood-prone areas.

Step 7: This step (application of indicators) involved the scaling of indicators ranging from most to least suitable. Within each factor, the various indicators were combined resulting in a relative suitability rating for each factor.

Step 8: In this step (factor application) factors within factor groupings were ranked in accordance with their importance to facility siting (surface water). Factors were then combined to produce a relative suitability rating for the factor grouping.

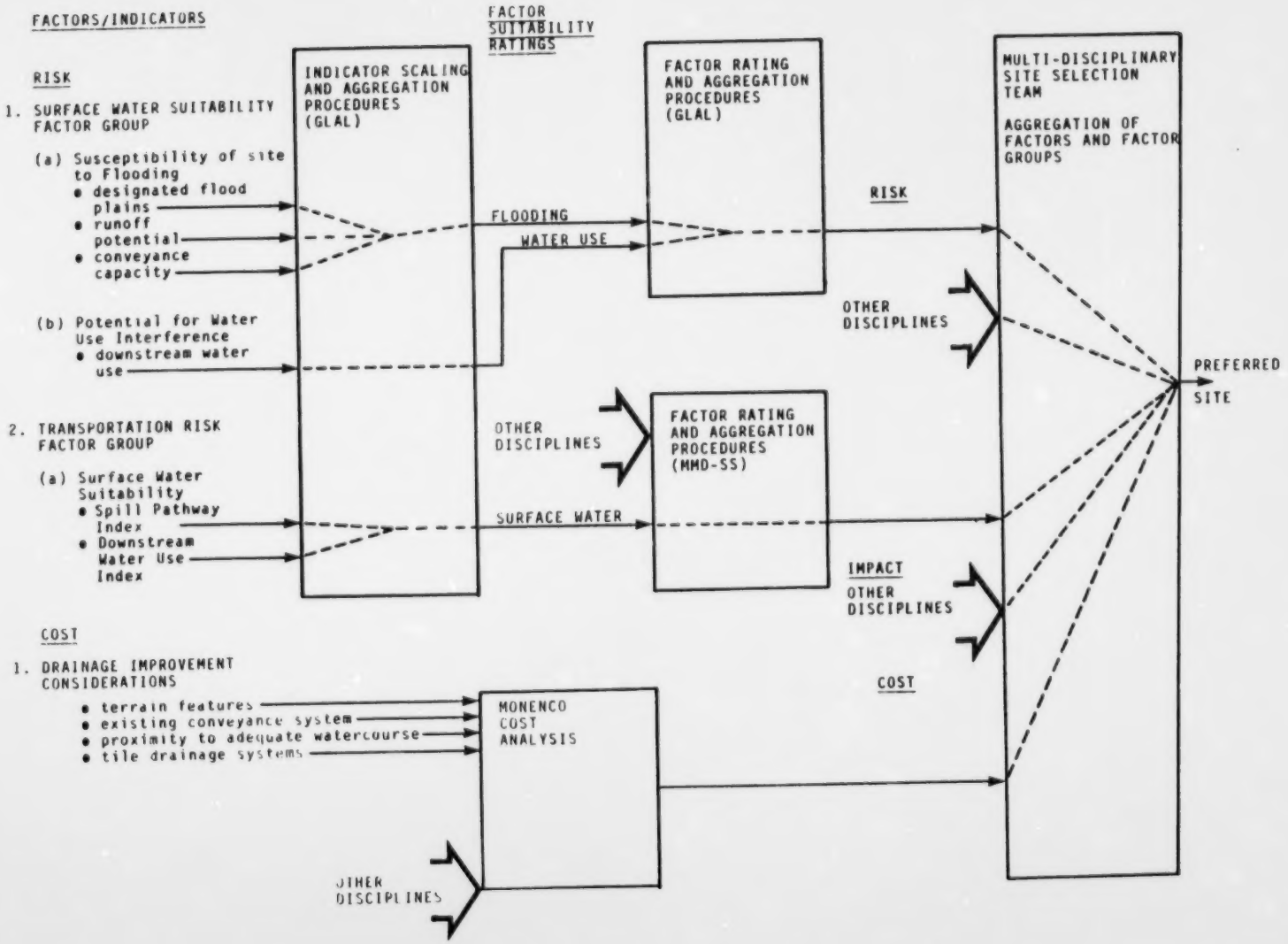
Step 9: During this step siting options were compared and ranked assuming that design changes developed during the consideration of mitigation step (#6) would be implemented. To test the sensitivity of the ranking of siting options to changes in assumptions and analysis methods a series of analyses were undertaken.

Step 10: The final step in the evaluation process was the documentation of the process and the rationale for rankings.

Public input and/or review was incorporated at several points in the evaluation process as indicated in Figure 21.

Considerable interaction occurred among consultants during the detailed comparative evaluation of facility siting options. This was particularly true where more than one consultant was responsible for input to a factor or factor grouping. The relationship of the GLAL surface water team

FIGURE 22 ROLE OF SURFACE WATER IN THE DETAILED COMPARATIVE EVALUATION OF FACILITY SITING OPTIONS



and its sub-consultant M. M. Dillon Ltd. to other consultants and the site selection team is depicted in Figure 22. Data interchange among consultants is listed in Appendix B.

3.2 FACTOR AND INDICATOR IDENTIFICATION

3.2.1 BASIS FOR FACTOR SELECTION

In Phase 3B, a surface drainage factor was used to identify candidate sites. This factor encompassed considerations in relation to surface drainage efficiency, potential drainage constraints and ease of implementing drainage controls (GLAL, 1984b).

At the beginning of Phase 4A the surface water factor was reviewed and revised. The single surface drainage factor was replaced with three factors selected to address OWMC's site selection goals described previously.

These surface water factors were as follows:

- Surface Water Suitability Factor Grouping (Risk)
  - (a) Susceptibility of Site to Flooding
  - (b) Potential for Water Use Interference, and

- Transportation Risk Factor Grouping
  - (a) Surface Water Suitability.

Drainage improvement considerations were included as a data input to the cost analysis.

3.2.1.1. Risk

To address the risk to human health issue it was necessary

to assess the sources of contamination, the "pathways" through which contaminants might move and the "receptors" that might be affected.

Three potential sources of contaminants to surface water were identified (see Figure 23). These sources were:

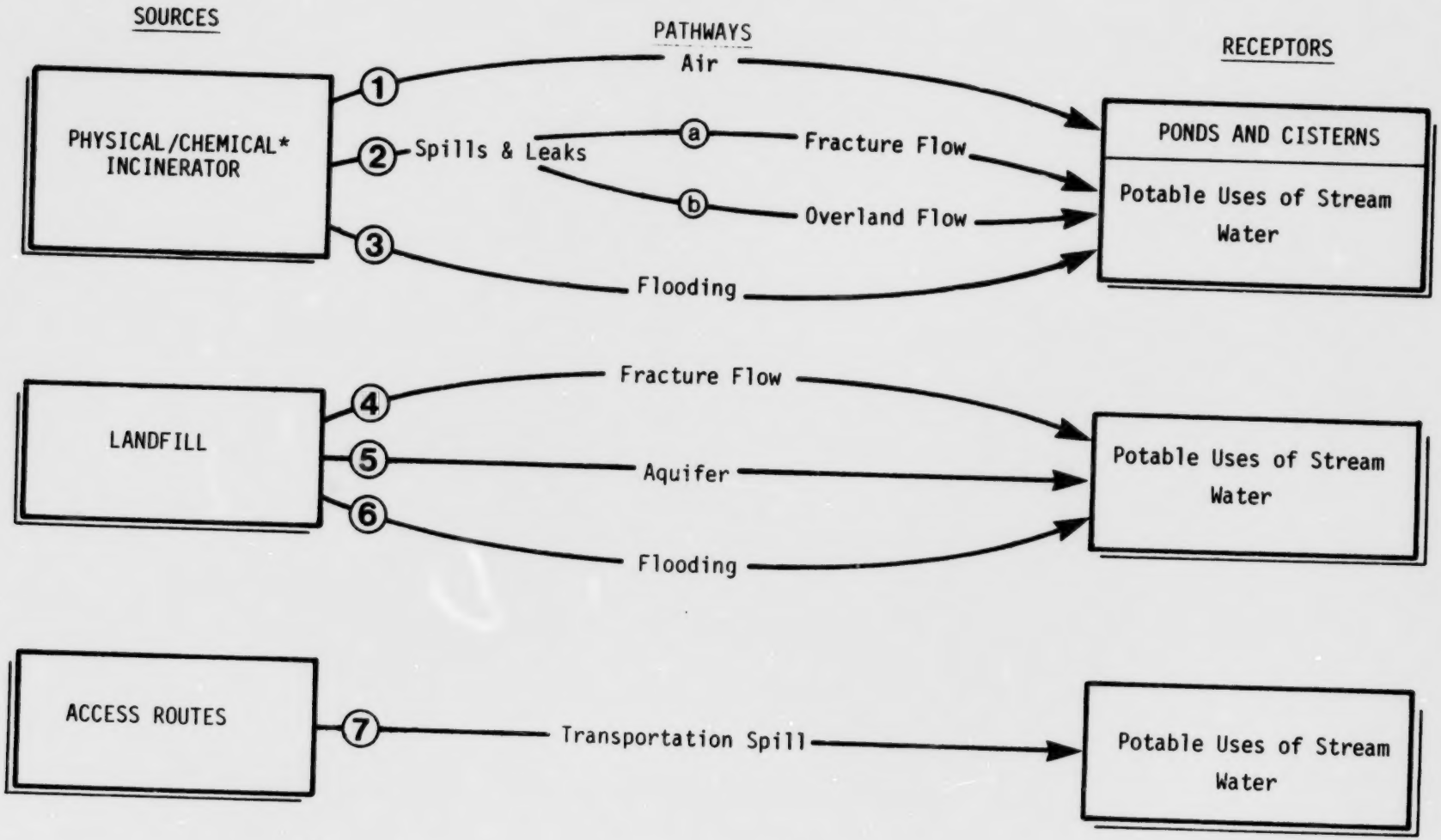
- spills and leaks from on-site facility operations associated with the physical/chemical treatment plant and the incineration plant;
- leachate movement from the landfill, and
- transportation spills along local and regional access roads.

Figure 23 also shows the major pathways and receptors from a surface water point of view for the above-mentioned sources. Seven major potential pathways were identified. Pathway #1 (stack and fugitive emissions from the facilities to the air and subsequent deposition on ponds and cisterns used as potable sources of water) was considered by the Ontario Research Foundation (Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Atmospheric Conditions, Ontario Research Foundation, 1985). Data on ponds and cisterns collected by GLAL were provided to ORF for inclusion in their analysis.

Ground water pathways (#2a, 2b, 4 and 5) were investigated by GLAL - Hydrogeology, (Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Geologic, Hydrogeologic and Geotechnical Considerations, Gartner Lee Associates Limited, 1985b).

As Figure 23 indicates, ground water/surface water connections exist for several pathways. For example, there is the

FIGURE 23 SURFACE WATER POTENTIAL SOURCES, PATHWAYS AND RECEPTORS (RISK)



* Physical/Chemical Treatment Plant and Incinerator

potential for spills and leaks from the physical/chemical treatment plant and incinerator plant or leachate from the landfill to move laterally through the weathered zone of the soil and discharge to local streams. Furthermore, contaminants could move downward to contaminate aquifers beneath the site which could in turn (ultimately) discharge to surface waters. It should be noted, however, that this is a concern common to all sites and has therefore not been included in the surface water comparative analysis. The question of contamination of aquifers, with ultimate discharge to surface water is addressed in the hydrogeology report (Gartner Lee Associates Limited, 1985b). The remaining flooding pathways (#3 and 6) were identified as a site selection factor for surface water.

The receptor for many of these pathways was considered to be downstream water uses (i.e. people who consumed the water). The two surface water factors relating to human health risk (susceptibility of the site to flooding, and potential for water use interference) together formed the surface water suitability factor grouping.

There is also a risk to human health in the event that a transportation spill along a local or adjacent access route results in the spillage of hazardous wastes to a watercourse. This pathway and the receptors (downstream water use, see Figure 23) were considered in the surface water suitability factor that formed part of the transportation risk factor grouping.

Other factors in this factor group were addressed by the Transportation consultant and other consultants (see Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection,(M. M. Dillon Ltd., 1985a).

3.2.1.2 Impact

Factors and studies relating to the impact on the natural environment, including watercourses downstream from facility siting options, were undertaken by GLAL biologists (see Site Selection Process, Phase 4A: Selection of a Preferred Site - Biology, Gartner Lee Associates Limited, 1985a).

3.2.1.3 Cost

The extent and scope of drainage improvement considerations both on-site and off-site were considered by the GLAL surface water study team. Data from this analysis were provided to Monenco Ltd. for input to the cost analysis.

3.2.2 BASIS FOR INDICATOR SELECTION

Once surface water factors were identified a number of indicators were selected for each factor. An indicator is an element or component of a factor. During the initial stages of Phase 4A, indicators provided a focus for the data collection efforts.

The factors and indicators identified at the onset of Phase 4A, are listed in Table 17. Factor sheets for factors remaining after screening are contained in Appendix A.

3.2.3 FACTOR AND INDICATOR DESCRIPTIONS

This section presents a brief description of the Phase 4A factors and indicators. Additional information is contained in the "factor sheets" presented in Appendix A.

3.2.3.1 Surface water suitability (risk) factor grouping

This factor group considers the potential risk to human health associated with the operation of a waste treatment facility

TABLE 17 INITIAL FACTORS AND INDICATORS FOR THE DETAILED COMPARATIVE EVALUATION OF SITING OPTIONS

FACTOR GROUPING/FACTOR/ DATA INPUT	INDICATOR
1. SURFACE WATER SUITABILITY (RISK)	
a) SUSCEPTIBILITY OF SITE TO FLOODING	• Designated floodplains and flood-prone areas
	• Runoff potential
	• Conveyance capacity
b) POTENTIAL FOR WATER USE INTERFERENCE	• Downstream water use
2. TRANSPORTATION RISK	
a) SURFACE WATER SUITABILITY	• Spill pathway index
	• Downstream water use index
3. COSTS	
a) DRAINAGE IMPROVEMENT CONSIDERATIONS (DATA INPUT)	• Terrain features
	• Existing surface runoff conveyance systems
	• Proximity to adequate receiving watercourse
	• Tile drainage systems

to downstream water users through the surface water pathway. Two factors are considered in this group, i.e. susceptibility of the site to flooding and the potential for interference with downstream water uses.

The susceptibility of the site to flooding factor considers potential sources of site flooding including on-site and off-site generated runoff. This includes, for example, local site drainage, back-up from receiving streams and/or runoff generated from an upstream drainage area passing through the site. Site flooding is considered as a site selection factor because of its importance as a potential pathway for contaminant movement to humans. Flooding of an operational portion of a waste treatment facility creates the potential for disruption of facility operations and the potential for transport of contaminants off-site into receiving waters. The result may be an increased risk to human health and the environment and is dependent upon downstream water uses.

A measure of the extent of flooding that may occur at a site is provided by the designated floodplains and flood-prone areas indicator. An accurate delineation of floodplains is available where engineered flood lines have been determined (e.g. Regional Storm Floodplains designated by Conservation Authorities). Unfortunately, engineered flood lines were available only for parts of some sites. Where engineered flood lines were not available flood-prone areas were identified through interpretation of aerial photography, and input from local residents. This method was considered to be appropriate for site selection purposes.

To refine the estimate of flood susceptibility provided by air photo interpretations, two additional indicators were considered. These were runoff potential and conveyance capacity.

Runoff potential considers the peak runoff generated on site and upstream from the site and which must be conveyed through or around the site. Runoff potential was calculated for a range of possible meteorological events such as the 5, 10, 50 and 100 year return period storms. Appropriate event durations were selected for each site, depending on the time of concentration of the upstream catchment. Runoff potential forms the basis for estimating the adequacy of existing outlet culverts/bridges and channels and for determining approximate depth of flooding at these outlets.

The conveyance capacity indicator relates to the rate of flow that can be conveyed by a bridge or culvert without back up of water onto the site. Conveyance capacity is also an indicator of drainage improvements that will be required during the construction phase, e.g. constructing larger culverts to reduce site flooding.

The potential for water use interference factor considers existing and known future major uses of surface water downstream from the waste treatment facility. Surface water use was considered a site selection factor because of its importance as a potential "receptor" of contaminants leaving a site. A waste treatment facility has the potential to interfere with downstream use of surface water by causing a risk to human health should any of the following occur: accidental spills at the facility site, accidental discharge of contaminated storm water, flooding of operational areas and contaminant movement to surface waters.

The facility will be designed to minimize this potential health risk (Status Report, Facility Design, Monenco Ltd., 1985a). Treated wastes will not be discharged to receiving waters. Potentially contaminated and uncontaminated storm water will be collected separately.

Contaminated storm water will be treated. Uncontaminated storm water (proven by testing) would be discharged to local streams. Emergency response crews will be situated at the facility to contain and clean up spilled wastes.

Nonetheless, in the unlikely event that contaminants do enter surface watercourses the potential risk to human health can be mostly mitigated by monitoring downstream water quality, and if contaminated, providing alternate water supplies.

The indicator of this factor is downstream water uses. This indicator includes present and known major future uses of surface waters downstream from the storm water outfall that potentially could be affected by contaminated stream water. Individual water uses were identified in the downstream portion of the site vicinity study area from interviews and public meetings. These uses included surface water takings for potable, domestic, and agricultural uses. On a regional scale, i.e. from the candidate sites to Lake Ontario or the Niagara River/Chippawa Power Canal, major uses were identified, such as municipal and industrial water intakes and outfalls. The length of stream passing through sensitive land uses was used as a surrogate measure of sensitive water use in the downstream (regional) study area.

3.2.3.2 Transportation risk factor grouping

The transportation risk factor group considers the potential risk to human health associated with transportation of hazardous wastes and reagents along access routes to the facility siting options. Several factors are included in this group of which transportation risk - surface water suitability is one. For a discussion of the other transportation factors see the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Transportation, (M. M. Dillon Limited, 1985b).

The transportation risk - surface water suitability factor takes into consideration the possibility of an accidental release of hazardous wastes to a watercourse during transit. The factor was designed to facilitate comparison of facility siting options on the basis of preferred access roads. It incorporates consideration of both "pathways" and "receptor" components. These are - the length of access road having a high risk of waste entry to a stream in the event of a transportation spill (known as stream crossing distance), the potential for a spill along an access road and downstream water usage. The factor consists of two indicators as follows:

- spill pathway index, and
- downstream water use index.

Spill Pathway Index (SPI). This indicator provides a measure of the potential for spilled wastes to enter a watercourse. It combines a hazard based spill index along local and regional access roads with the proportion of the access road where spilled wastes are likely to enter watercourses, the number of in-transit vehicle spills and the number of vehicles anticipated on a road section.

The hazard based spill index consists of spill frequency values and weighting factors. The hazard based spill index considers the type of waste being hauled, e.g., special wastes, additives and reagents and treated wastes. Spill frequency values were determined by the Transportation consultant which provided an estimate of the potential for a waste spill occurring along a particular access route. For a complete discussion of these indices see M. M. Dillon Limited (1985b).

The proportion of the access road where spilled wastes may enter watercourses consists of the ratio of stream crossing distance to access road length, for each link of the route.

The stream crossing distance consists of two components -- the length of access road within the top-of-bank floodplain, where a spill could have direct access to a stream, and an adjacent slightly sloping land segment where a spill could travel to a stream before an emergency response team could intercept it. The stream crossing distance and the method used to derive it are explained in detail in the separate Technical Appendix.

The SPI was determined by multiplying the ratio of stream crossing distance to access route link length by the hazard based spill index, and summing over the entire route length.

The Downstream Water Use Index (DSWUI) indicator provides a measure of the significance of a spill to downstream receptors, should it enter a stream.

Sensitive water uses were considered to include those that may involve water contact or consumption, e.g. municipal water supplies, rural water takings for potable and/or domestic supply and certain recreational uses such as swimming and camping. Large consumers of stream water, such as municipal or communal water intakes, could be identified through agency contact. It was not considered necessary for site selection purposes to conduct interviews with residents along watercourses downstream from the various access road crossings all the way to the point of discharge into one of the Great Lakes. An indication of "sensitive" water use in this study area was obtained by measuring the stream length passing through sensitive land uses such as rural, wooded and recreational land where it was assumed there would be a greater likelihood of surface water consumption. This information provided the basis for a downstream water use index that could be used for comparative evaluation of siting options.

3.2.3.3 Data Inputs to Cost Analysis

Drainage improvement considerations were studied by the GLAL surface water study team and the results provided to the engineering consultants for inclusion in their cost analysis (Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Engineering, Monenco Limited 1985b).

Data inputs for drainage improvement considerations related to the relative ease or difficulty in implementing on-site and off-site drainage works required to convey runoff from and/or through the site and downstream to an adequate receiving body. Costs for site development are influenced by the scope of work required to control drainage. The scope and cost of surface drainage works are influenced by the existing

terrain and drainage features, the quantity of water to be handled, the capacity of existing watercourses and structures for water conveyance, the existence and extent of field tile drainage systems, and the availability and proximity to an adequate receiving watercourse.

3.2.4 STUDY AREAS AND TIME FRAMES

The study areas and time frames that are associated with each of the surface water factors are depicted in Table 2 and discussed in Section 1.3.3.2. Four study areas pertain to the comparison of siting options as follows:

1. site;
2. site vicinity;
3. regional; and
4. access routes.

Flooding and drainage were investigated in the site and site vicinity study areas. Water uses were identified in the site vicinity study area and also at a regional scale for watercourses downstream from candidate sites and access route stream crossings to Lake Ontario on the Chippawa/ Queenston Power Canal. The fourth study area was the access roads themselves (as opposed to downstream watercourses). Stream crossing distances were calculated in the access route study area.

Three time frames were identified as follows (see also Table 1 and Section 1.3.3.2).

1. construction phase;
2. operational phase; and
3. post-operational phase.

Flood susceptibility and potential water use interference factors were considered in all three time frames. Flooding was considered to pose a risk during all phases of facility construction and operation and post-closure. Similarly, water uses could be effected during construction (sediment, gasoline spills, etc.) during operation (spills, leaks) and after site closure. Transportation risk to surface water was considered to be a risk only during the operational phase. Drainage improvements were considered only during the construction phase.

3.3 DATA COLLECTION AND ANALYSIS

The second and third steps in the Phase 4A detailed comparative evaluation of facility siting options from a surface water perspective were data collection and analysis. Details on the methods used to collect and analyze surface water data and the results of these analyses are contained in the Technical Appendix of this report and summarized below.

3.3.1 DATA COLLECTION

In addition to the review of on-hand data and material obtained through previous OWMC phases, three distinct approaches

were used to collect data for the Phase 4A surface water studies, these were:

1. meetings and discussions with various agencies;
2. meetings, discussion and site tours with local residents; and
3. roadside visits to make observations and measurements.

3.3.1.1 Agency contact

Meetings with agencies were arranged in cooperation with OWMC. The bulk of the meetings took place during May, June and July, 1984. In most cases meetings with agencies resulted in a great deal of information being made available in the form of reports, maps and raw data. Available floodplain mapping and water taking permits were obtained through agency contacts.

3.3.1.2 Public contact

The public contact data collection process consisted of the following tasks:

1. distribution of a questionnaire containing questions concerning surface water features;

2. meetings and discussions with site and site vicinity residents to present our preliminary findings and to receive local input on water use, flooding and drainage;

3. site inspection with local residents to view significant surface water features; and

4. follow-up meetings with site groups to present preliminary findings prior to map finalization, to discuss issues and to obtain feedback on our findings.

The public contact process assisted in the identification of local surface water uses, flooding and drainage characteristics.

3.3.1.3 Field studies

Roadside visits were conducted at each candidate site to aid in the assessment of the relative flood susceptibility and potential drainage improvements that may be required. Specific tasks undertaken during field studies were as follows:

1. the identification and measurement of opening areas of culverts and bridges;

2. the observation and photographing of swales and channels on and downstream from the sites;

3. the verification, where possible, of drainage boundaries; and

4. a general assessment of the relative ease or difficulty of draining each candidate site.

3.3.2 DATA ANALYSIS

3.3.2.1 Flood susceptibility

The data collected from topographic mapping, air photography, and during site visits were used in the assessment of the flood susceptibility of each of the sites.

Designated floodplains were mapped using information obtained from Conservation Authorities. Flood-prone areas were identified from interpretation of air photographs and mapped.

Estimates of the peak runoff volume that must be accommodated by culverts, swales and channels draining the site was estimated by the Rational Method (Handbook of Applied Hydrology, Chow 1964). A general assessment of the capacity of outlet channels and swales to convey runoff away from or through the site was obtained by comparing the culvert capacity/channel capacity to the estimated peak flow.

3.3.2.2 Drainage improvement considerations

The available 1:10,000 scale mapping and site visits were the primary sources of data used in the assessment of potential drainage improvements required at each site. The walk-and-talk questionnaire, 1:50,000 scale topographic mapping and air photography were also useful.

Drainage features, watershed boundaries, overtopped culverts, etc. were mapped and reviewed in consultation with the engineering consultant (Monenco, Ltd.) to identify preliminary drainage improvements that might be required for facility development, e.g. perimeter ditching, channelization, stormwater management ponds and berms.

3.3.2.3 Water use

Water uses identified from the walk-and-talk questionnaire, and site tours, agency contacts and previous OWMC work were mapped on 1:50,000 and 1:10,000 scale maps.

To provide an indication of the extent of low volume "sensitive" water uses streams passing through rural, wooded and recreational land use were identified and measured on 1:25,000 scale topographic maps. It was assumed that these land uses could support low-volume sensitive users, e.g. potable water supplies, crop irrigation and livestock watering. This surrogate measure of water use provided an estimation of the extent of potential sensitive water uses in areas not covered by the walk-and-talk questionnaires and site visits.

3.3.2.4 Access roads

A measure of the potential for spilled wastes to enter a stream along OWMC's access roads was provided by the "stream crossing distance" parameters. This value was measured on 1:25,000 scale topographic maps (floodplain width) and/or calculated from standard engineering nomographs (critical overland flow length).

3.4 FACTOR AND INDICATOR SCREENING

Prior to the actual comparative evaluation of siting options the surface water factors and indicators were reviewed and screened (Step 4). Screening involved the elimination of factors and/or indicators from consideration in the surface water evaluation of siting options. Consideration was given to dropping factors/indicators on the basis of the following:

- there were no differences among options,
- there were insignificant levels of risk, impacts or costs,
- the information collected consisted of data inputs rather than indicators of risk, impact or costs, and
- a duplication of measurements.

All surface water factors and indicators were applied. Table 18 contains a summary of the status of the surface water factors and indicators (applied/screened). The rationale for this status is summarized in Appendix C.

3.5 BASIC ACCEPTABILITY ANALYSIS

3.5.1 INTRODUCTION

Analysis of the candidate sites' basic acceptability was conducted in parallel to the detailed comparative evaluation of sites. This analysis was concerned with potentially severe constraints. A constraint, if considered severe enough, could result in the rejection of a site regardless of the suitability of the site in terms of other factors.

In the basic acceptability analysis new data collected in Phase 4A for all factors were reviewed to determine whether or not there were any situations where a site should be rejected irrespective of its relative suitability. From the surface water perspective the basic acceptability analysis focused on the three surface water factors, i.e.

TABLE 18 SCREENING OF INITIAL FACTORS AND INDICATORS - SUMMARY

FACTOR GROUPING/FACTOR/INDICATOR	STATUS	COMMENTS
A. SURFACE WATER SUITABILITY (RISK) FACTOR GROUPING	Applied	(by surface water team)
1. Susceptibility of Site To Flooding Factor	Applied	
a) Designated floodplains and flood-prone areas	Applied	
b) Runoff potential	Applied	
c) Conveyance capacity	Applied	
2. Potential for Water Use Interference Factor	Applied	
a) Downstream water use	Modified*	
B. TRANSPORTATION RISK FACTOR GROUPING	Applied	(by M.M. Dillon Limited transportation consultants)
1. Surface Water Suitability Factor	Applied	(by surface water team with inputs from M.M. Dillon Limited transporation consultants)
a) Spill pathway index	Applied	
b) Downstream water use index	Applied	

* See Appendix C for a discussion of how this indicator was modified.

- susceptibility of the site to flooding,
- potential for downstream water use interference, and
- surface water suitability (transportation).

3.5.2 SUSCEPTIBILITY OF THE SITE TO FLOODING

Site layouts prepared by Monenco Ltd. were superimposed on surface water features maps and potential conflicts with floodplains were noted. Since candidate sites had been screened on the basis of flooding during previous site selection phases, it was not surprising to find that only one potential constraint was identified.

The potential constraint identified was the floodplain associated with Beaver Creek on candidate site LF-3C. Although this flooding constraint was actually identified during Phase 3 studies, some uncertainty regarding the extent of the floodplain still remained after our Phase 4A investigations. Although the facilities layout prepared by Monenco Ltd. did not actually impinge upon the Beaver Creek floodplain the surface water team recommended that all operational components of the proposed facility, e.g. landfill cells, stormwater management ponds etc., be located at least 100 m south of the Beaver Creek floodplain (as delineated by our Phase 4A studies) to provide an added margin of safety in case the floodplain was underestimated. In fact the setback from the Beaver Creek floodplain was approximately 200 m (M.M. Dillon Limited, 1985a).

As a result of this analysis and recommendation the facility layout was modified and its potentially severe flooding constraint was removed.

3.5.3 POTENTIAL FOR DOWNSTREAM WATER USE INTERFERENCE

In previous site selection phases candidate sites were screened for the occurrence of a major sensitive water uses downstream from the site, e.g. a municipal water intake. In the basic acceptability analysis the water use information collected during Phase 4A was examined to see if any major sensitive water use existed downstream from the candidate sites.

The analysis revealed that although a number of water uses such as irrigation were identified there were no major sensitive water uses such as a municipal water intake. Furthermore, the analysis did not identify any future major water uses planned downstream of the candidate sites.

3.5.4 SURFACE WATER SUITABILITY (TRANSPORTATION)

The basic acceptability analysis for this transportation risk factor was similar to the analysis described in Section 3.5.3 above. The Phase 4A water use data were examined to see if there were any major sensitive water uses downstream from the access roads to the candidate sites.

The analysis identified a number of water uses such as irrigation but no major sensitive water use such as a municipal intake.

3.5.5 CONCLUSION

All sites and siting options were considered to be basically acceptable from the surface water perspective; however, relative differences among siting options existed and formed the basis for ranking of siting options.

In May 1985 candidate site LF-2N was dropped from further consideration because it failed to provide an acceptable level of natural containment. The reasons for this decision are documented in the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Interim Site Selection Report Candidate Site LF-2N, (M.M. Dillon, 1985c).

3.6 MITIGATIVE MEASURES CONSIDERED FOR SITING OPTIONS

Throughout Phase 4A the surface water team worked with Monenco Ltd. in an effort to minimize potential impacts on surface water wherever possible. The following surface water characteristics were considered in Monenco's preliminary facility design and cost estimates. It should be noted that these surface water drainage considerations were of a preliminary nature. The considerations were:

- on-site stormwater management ponds,
- location of stormwater outfalls,
- review of recommendation for no discharge of treated wastes to local streams,
- input to raw water supply locations,
- perimeter ditching,
- berms,
- downstream channel improvements,
- bridge/culvert improvements,
- re-routing of on-site drainage courses to avoid facility components,
- location of on-site access roads,

- modification of facility layout to avoid flood-prone areas on site, and
- segregation of potentially contaminated and uncontaminated stormwater collection systems.

In undertaking the detailed comparative evaluation of siting options described in the subsequent sections, the above-mentioned surface water drainage improvement considerations were considered to be incorporated in the basic design of the facility.

3.7 INDICATOR APPLICATION

3.7.1 DATA MATRICES

The Technical Appendix to this report presents the data concerning the surface water resources for the eight candidate sites. This information was compiled for the entire site (Phase 3B site acquisition boundaries), site vicinity regional and access route study areas. Prior to undertaking the detailed comparison of siting options it was necessary to compile this information according to relevant siting option combinations and site boundaries derived during the refinement of siting options stage. This information was organized into data matrices which reflect the applied factors and indicators.

On May 31, 1985 OWMC announced that candidate site LF-2N was dropped from further consideration because it failed to provide adequate natural containment (M.M. Dillon Limited, 1985c). Information concerning site LF-2N therefore has not been included in the data matrices or subsequent comparative analysis; however, surface water data for this site is presented in Chapter 3 of the companion Technical Appendix.

The data matrices which formed the basis for the comparison of siting options discussed in subsequent sections are presented in Appendix D.

3.7.2 SCALING

Using the data contained in Appendix D the indicators remaining after the review/screening process were then scaled (Step 7). This process involved converting data into units of relative desirability such as high constraint, medium constraint and low constraint. Depending on the indicator, the scaling system was derived from either qualitative or quantitative data. Scaling levels refer to relative differences among the various siting options considered and do not have meaning in absolute terms.

For qualitative indicators, e.g. designated flooaplains and flood-prone areas, the range of situations across the siting options was inspected and two or three levels defined. Similarly, for quantitative indicators, e.g. runoff potential, the range of data across the siting options was examined and two, three or four levels defined.

Table 19 presents the scaling systems used for each of the applied indicators along with the rationale for establishing these levels. The relative constraint levels developed through the scaling exercise are summarized in Table 20.

3.7.3 AGGREGATION

The indicator aggregation process involves the combining of indicators within factors into a single suitability rating for the factor. The aggregation of indicators was directed toward two products as follows:

TABLE 19 SUMMARY OF SYSTEM USED TO SCALE INDICATORS

A. SUSCEPTIBILITY OF SITE TO FLOODING

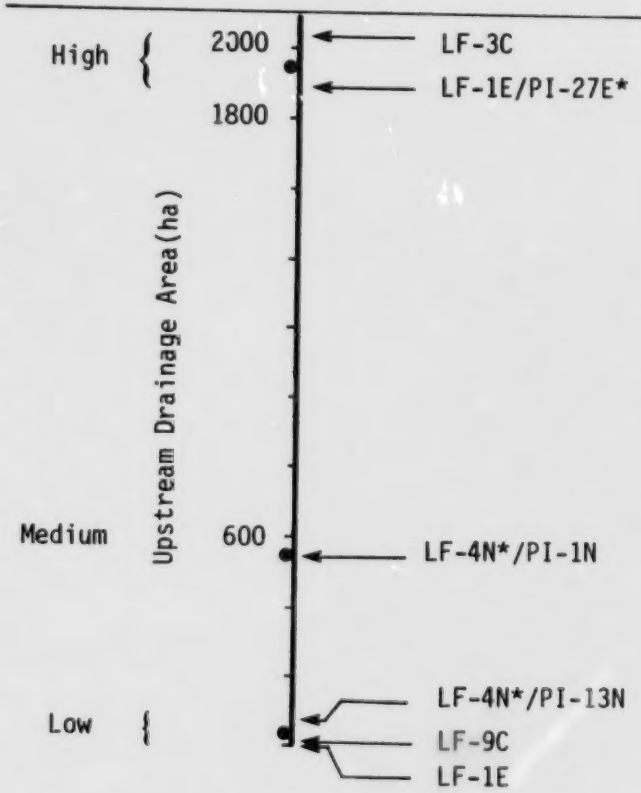
(a) Designated Floodplains and Flood-Prone Areas

RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
High	LF-3C	-a quantitative partitioning of the indicator into distinct levels was not possible, thus a qualitative scaling system was used -the qualitative scaling system used focused on major flooding occurrences that might effect operational areas of the site -the possibility of the need for engineering measures (e.g. berms) to provide additional flood protection for operational areas of the site was considered to be the boundary between "high" and "medium" levels
Medium	LF-4N/PI-13N LF-4N/PI-1N	-the division between "medium" and "low" levels was considered to be the presence or absence of flood-prone areas in the operational zone of the site that would have to be corrected during construction and the minor occurrence of designated floodplains on the site
Low	LF-1E LF-9C LF-1E/PI-27E	

TABLE 19 (cont'd) SUMMARY OF SYSTEM USED TO SCALE INDICATORS

A. SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

(b) Runoff Potential

RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
		- data distributed into three levels or data groupings - width of each level is small (about 7%, 0% and 3% of the range of observed data) - separation between midpoint (•) of each level is significant (about 27%) of the range for Low-medium and about 69% of the range for medium-high)

* For partially integrated options, site with greatest constraint is indicated with an asterisk (*)

TABLE 19 (Cont'd): SUMMARY OF SYSTEM USED TO SCALE INDICATORS

A. SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

(c) Conveyance Capacity

RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
High	LF-3C LF-9C LF-1E LF-1E/PI-27E	-the adequacy/inadequacy of existing outlets to convey runoff through and away from the site without flooding (existing conditions) was selected as the boundary for a two-level scaling system -while inadequate outlets (high relative constraint level) may be corrected easily by engineering methods there was a preference to avoid reliance on engineering for flood protection
Low	LF-4N/PI-13N LF-4N/PI-1N	-adequate outlet capacity indicates a natural low relative constraint level for the site with respect to flooding

TABLE 19 (cont'd) SUMMARY OF SYSTEM USED TO SCALE INDICATORS

B. POTENTIAL FOR WATER USE INTERFERENCE FACTOR

(a) Downstream Water Use Index

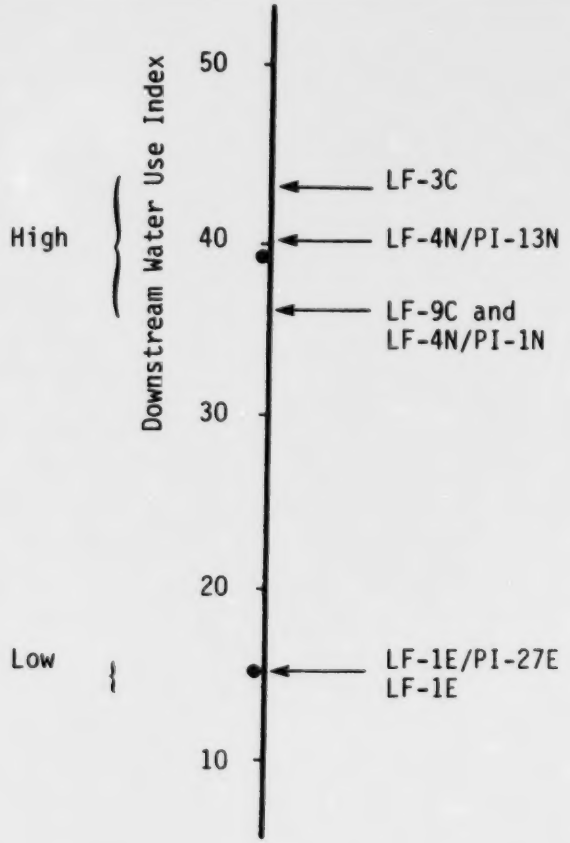
RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
		- data distributed into two levels or data groupings. - separation of mid-points of data groupings is significant (approximately 80% of the observed data range) - width of widest level (High) is approximately 25% of observed data range

TABLE 19 (Cont'd): SUMMARY OF SYSTEM USED TO SCALE INDICATORS

B. POTENTIAL FOR WATER USE INTERFERENCE FACTOR

(b) Number of Local Stream Takings for Potable Supply

RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
High (Presence)	LF-4N/PI-13N	-the presence or absence of stream takings for potable water supply in the immediate (local) downstream study area was considered to be the division between data groupings
Low (Absence)	LF-3C LF-4N/PI-1N LF-9C LF-1E LF-1E/PI-27E	-in the case of accidental spill of contaminants to streams, local water uses would be affected soonest, wastes would be relatively less diluted than downstream and notification time would be shortest

TABLE 19 (cont'd) SUMMARY OF SYSTEM USED TO SCALE INDICATORS

C. TRANSPORTATION RISK - SURFACE WATER SUITABILITY

(a) Spill Pathway Index

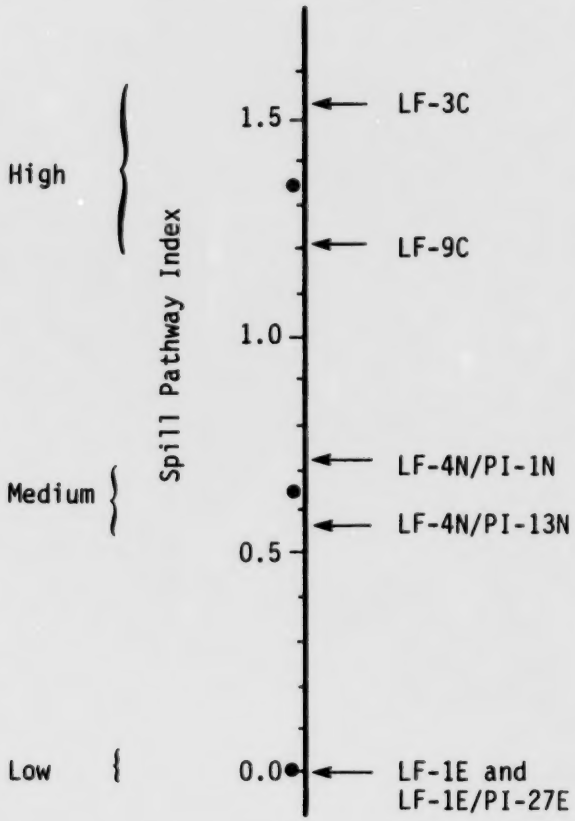
RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
		- data distributed into three levels or data groupings - separation of mid points of data groupings (•) is significant (42-47% of observed data range) - width of widest level (High) is 20% of observed data range

TABLE 19 (cont'd) SUMMARY OF SYSTEM USED TO SCALE INDICATORS

C. TRANSPORTATION RISK - SURFACE WATER SUITABILITY

(b) Downstream Water Use Index

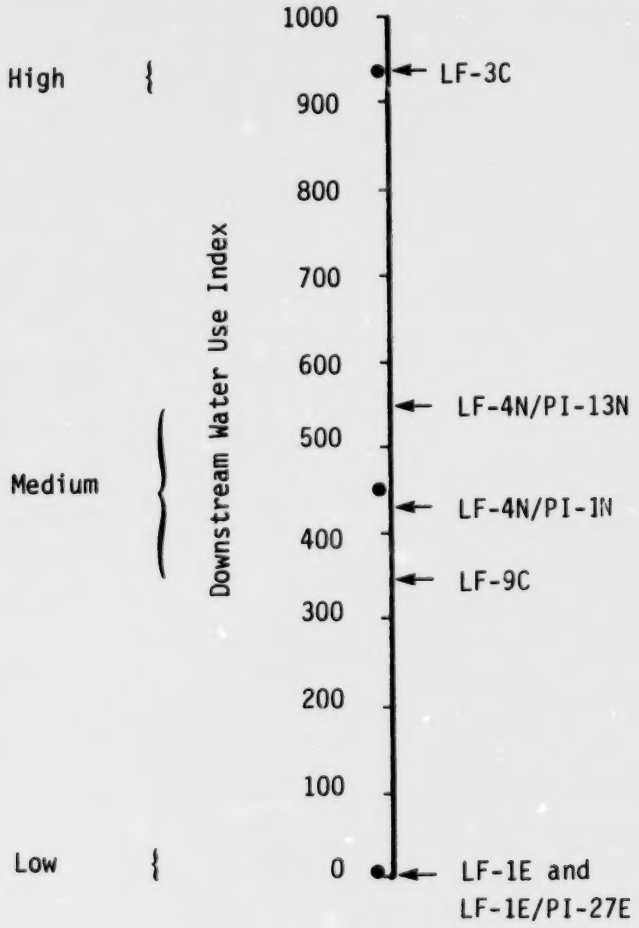
RELATIVE CONSTRAINT LEVEL	DISTRIBUTION OF SITES	RATIONALE FOR GROUPING DATA INTO RELATIVE CONSTRAINT LEVELS
		- distributed into three levels or data groupings. - separation of mid points of data grouping (•) is significant (40-54% of observed data range). - width of widest level (medium) is approx. 21% of observed data range.

TABLE 20 SUMMARY OF RELATIVE CONSTRAINT LEVELS DEVELOPED THROUGH SCALING EXERCISE

FACTORS/INDICATORS	LF-3C	LF-9C	LF-1E	LF-1E/ PI-27E	LF-4N/ PI-13N	LF-4N/ PI-1N
A. SUSCEPTIBILITY OF SITE TO FLOODING FACTORS						
a) Designated Floodplains and Flood-Prone Areas	High	Low	Low	Low	Medium	Medium
b) Runoff Potential	High	Low	Low	High	Low	Medium
c) Conveyance Capacity	High	High	High	High	Low	Low
B. POTENTIAL FOR WATER USE INTERFERENCE FACTOR						
a) Downstream Water Use Index	High	High	Low	Low	High	High
b) Number of Local Stream Takings for Potable Supply	Absent	Absent	Absent	Absent	Present	Absent
C. TRANSPORTATION RISK - SURFACE WATER SUITABILITY FACTOR						
a) Spill Pathway Index	High	High	Low	Low	Medium	Medium
b) Downstream Water Use Index	High	Medium	Low	Low	Medium	Medium

1) A factor suitability rating for each factor, and

2) A summary matrix highlighting major features considered in the development of the factor suitability rating.

In terms of factor suitability ratings, a seven-level system was used for surface water (see Figure 24) to reflect relative differences across the siting options. The highest level of constraint in this system was Level -6. If a factor was rated Level -6 it was considered to represent a potentially exclusionary condition. Since exclusionary constraints from the surface water perspective were addressed in previous site selection phases, e.g. avoidance of floodplains, no Level -6 situations were identified. Levels -5 to -1 represent relative levels of suitability for a factor, as described in Figure 24. Level -1 is the highest level of relative suitability. Level +1 actually represents a positive, unconstrained selection. No Level +1 situations were identified for surface water. Level -5 represents the lowest level of relative suitability observed for surface water.

The first step in aggregating indicators within each factor was to determine the relative importance of indicators. Table 21 summarizes the individual indicator ratings for each factor and the rationale for this rating. The second step in the aggregation process was to define factor suitability rating levels in terms of the different indicator scaling levels. Table 22 provides the definition of suitability ratings levels for each surface water factor and the rationale for these definitions.

FIGURE 24 FACTOR SUITABILITY RATING SYSTEM DEVELOPED TO HIGHLIGHT RELATIVE DIFFERENCES AMONG SITING OPTIONS

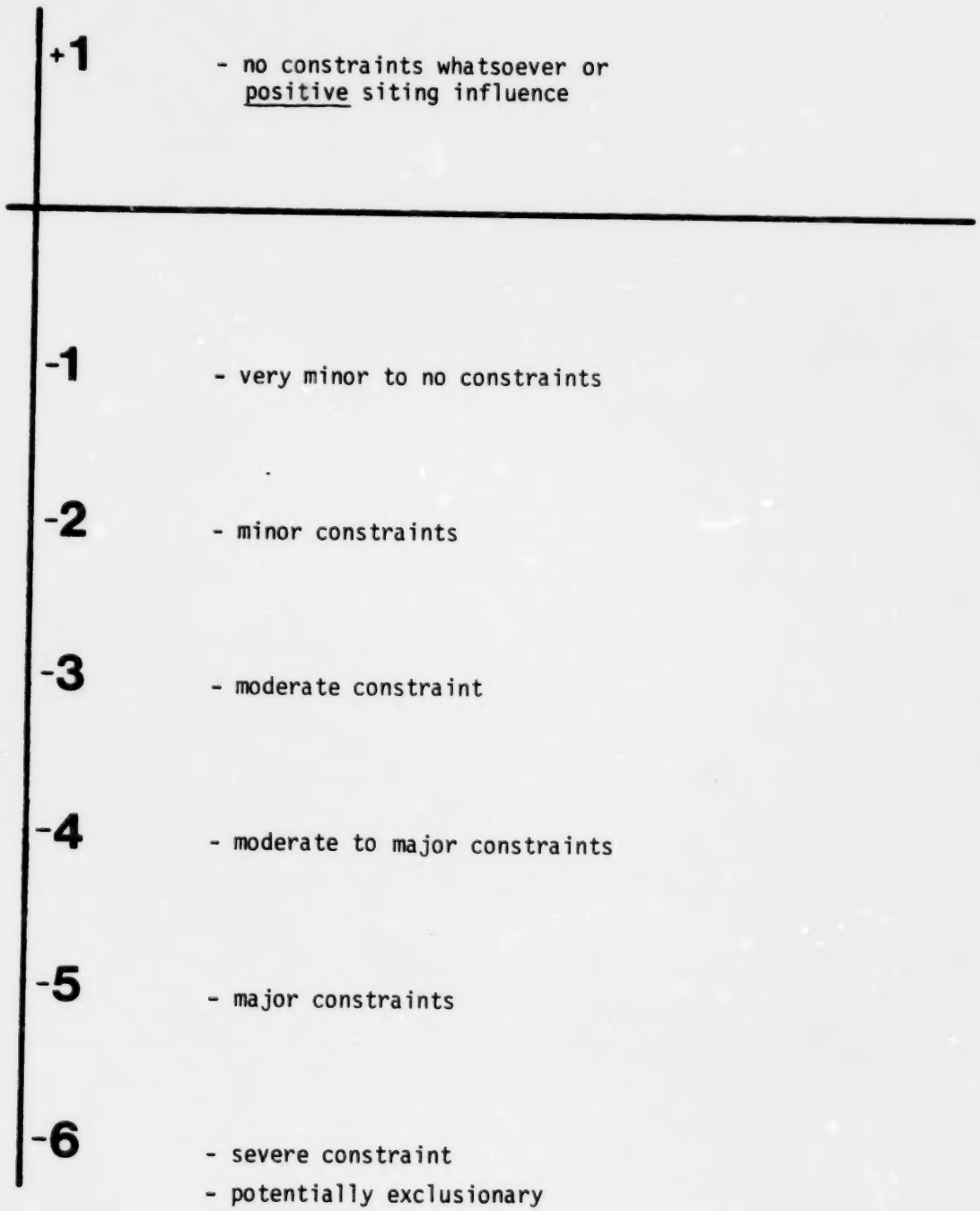


TABLE 21 RATING OF INDICATORS BY FACTOR

FACTOR/INDICATOR	RELATIVE IMPORTANCE OF INDICATOR	RATIONALE
1. Susceptibility of Site to Flooding Designated floodplains and flood-prone areas	High	Designated floodplains have been established by engineering methods and, as such, provide a reliable, defensible measure of site flood susceptibility. Flood-prone areas identified by air photo interpretation also provided a good indication of site flood susceptibility where engineered flood lines were unavailable.
Runoff Potential	Low	This indicator was used in the establishment of adequacy of culverts/bridges which convey runoff off-site. It provided a measure of peak runoff generated from existing sites. It was considered of secondary importance to the designated floodplain indicator because it was used to refine the interpretation of flood susceptibility provided by the "designated floodplains and flood-prone areas" indicator.
Conveyance Capacity	Low	This indicator was used in the assessment of adequacy of outlets to convey runoff through and away from the site. It was considered of approximately equal importance to the "runoff potential" indicator but of secondary importance to "designated floodplain and flood-prone areas" indicator. It was used to refine the interpretation of flood susceptibility provided by the first indicator.

TABLE 21 (Cont'd)

FACTOR/INDICATOR	RELATIVE IMPORTANCE OF INDICATOR	RATIONALE
2. Potential for Water Use Interference	Low	This indicator was considered to be of secondary importance to number of local potable uses indicator. It provided a measure of the significance of downstream uses at a regional scale. It is dependent on the assumption that downstream land uses and water uses are related.
Downstream Water Use		
Number of Local Stream Takings for Potable Supply	High	In case of accidental spills and waste entry to a stream users of streams for potable water supply would be effected soonest, wastes would be relatively undiluted and there would be a short time available for notifying these users. Consequently, this indicator was considered to be the most important.
3. Transportation Risk to Surface Waters		
Spill Pathway Index	High	This was considered to be the most significant indicator because it provided a quantitative basis for comparison of siting options. It represents the potential for waste entry to a stream following an accident and provides a measure of the significance of the "pathway".

TABLE 21 (Cont'd)

FACTOR/INDICATOR	RELATIVE IMPORTANCE OF INDICATOR	RATIONALE
Transportation Risk to Surface Waters (Cont'd)		
Downstream Water Use Index	Low	This was considered to be of secondary importance to the previous indicator because it provides a measure of the significance of downstream "receptors" i.e. water uses. Stream lengths through "sensitive" land uses are considered to be representative of downstream low-volume "sensitive" water use. It was a qualitative indicator but highly dependent on the above assumption that land use and water use are related.

TABLE 22 AGGREGATION OF INDICATORS

A. Susceptibility of Site to Flooding Factor

RELATIVE SUITABILITY LEVEL	RELATIVE SCALING LEVEL FOR INDICATOR			SITING OPTIONS	RATIONALE
	DFP*	RP	CC		
-6				None	
-5	H	H	H	LF-3C	- highest relative level of constraint due to large upstream drainage area and backwater from Welland River which are not easily mitigated. - some reliance on engineering may be necessary
-4				None	
-3	M	M	L	LF-4N/PI-1N	- middle level of relative constraint due to proximity of significant floodplain of Indian Creek
	M	L	L	LF-4N/PI-13N	
-2	L	H	H	LF-1E/PI-27E	- second lowest relative level of constraint due to large upstream area for Grassy Brook
-1	L	L	H	LF-1E	- lowest level of relative constraint
	L	L	H	LF-9C	- flooding not considered to be a concern

*DFP = Designated Floodplains and Flood-Prone Areas
RP = Runoff Potential
CC = Conveyance Capacity
H = High
M = Medium
L - Low

TABLE 22 (Cont'd)

B. Potential for Water Use Interference Factor

RELATIVE SUITABILITY LEVEL	RELATIVE SCALING LEVEL FOR INDICATOR		SITING OPTIONS	RATIONALE
	DSWUI*	NPU		
-6			None	
-5	H	P	LF-4N/PI-13N	- highest relative level of constraint due to location of potable uses immediately downstream from the site and high DSWUI.
-4			None	
-3	H	A	LF-4N/PI-1N LF-3C LF-9C	- middle level of relative suitability - no potable uses immediately downstream from the site and high DSWUI.
-2			None	
-1	L	A	LF-1E LF-1E/PI-27E	- lowest relative level of suitability due to no potable uses immediately downstream from the site and low DSWUI.

* DSWUI = Downstream Water Use Index
NPU = Number of Local Potable Uses
H = High
L = Low
P = Present
A = Absent

TABLE 22 (Cont'd)

C. Transportation Risk to Surface Waters

RELATIVE SUITABILITY LEVEL	RELATIVE SCALING LEVEL FOR INDICATOR		SITING OPTIONS	RATIONALE
	SPI*	DSWUI		
-6			None	
-5	H	H	LF-3C	- highest relative level of constraint - SPI slightly higher than LF-9C - both indicators are high
-4	H	M	LF-9C	- second highest relative level of constraint - SPI higher than LF-4N/PI-13N and LF-4N/PI-1N
-3	M	M	LF-4N/PI-1N LF-4N/PI-13N	- middle level of constraint - SPI and DSWUI both medium
-2			None	
-1	L	L	LF-1E LF-1E/PI-27E	- lowest relative level of constraint - zero SPI and DSWUI

* SPI = Spill Pathway Index
DSWUI = Downstream Water Use Index
H = High
M = Medium
L = Low

Suitability ratings for each surface water factor are summarized for the six facility siting options in Table 23.

3.8 FACTOR APPLICATION

The indicator application procedure described in the previous section combined indicators for each factor and resulted in a factor suitability rating for each siting option (Table 23). In this factor application step these factor suitability ratings are combined to produce a single suitability rating for factor groupings for each siting option. For example, suitability ratings for the susceptibility of the site to flooding factor and the potential for water use interference factor were combined to produce a single suitability rating for the surface water suitability factor grouping for each siting option.

In combining these two factors to produce a single rating, the potential for water use interference factor was considered to be more important than the site flooding factor. The reasons for this decision are:

- severity and frequency of flooding expected to be low at most sites;
- area affected by flooding is relatively small contrasted to large potential area that could be affected downstream;
- flooding concerns can be mitigated, and are addressed in the preliminary facility design, and
- the provision of alternative water supplies has not been assumed in the comparative evaluation of siting options.

TABLE 23 SUMMARY OF RELATIVE FACTOR SUITABILITY RATINGS FOR FACILITY SITING OPTIONS

FACTOR	FACILITY SITING OPTIONS					
	FULLY INTEGRATED			PARTIALLY INTEGRATED		
	LF-3C	LF-9C	LF-1E	LF-1E & PI-27E	LF-4N & PI-13N	LF-4N & PI-1N
Susceptibility of Site to Flooding	-5	-1	-1	-2	-3	-3
Potential for Water Use Interference	-3	-3	-1	-1	-5	-3
Transportation Risk to Surface Waters	-5	-4	-1	-1	-3	-3

A seven-level relative suitability rating system was developed for the surface water suitability factor grouping. This rating was similar to the rating system developed for factors, (see, for example, Figure 24). The suitability levels are defined in Table 24.

The surface water team was not solely responsible for aggregating factors in the Transportation Risk Factor Grouping since several consultants were involved in data collection and analysis. For a discussion of the development of suitability ratings for the Transportation Risk Factor Grouping see M. M. Dillon Limited, (1985a, 1985b).

3.9 SITING OPTION COMPARISON

The relative suitability levels for the surface water suitability factor grouping presented in Table 24 were used to provide a ranking of siting options. Options are ranked in Table 25 in order of preference.

RATIONALE

Integrated site LF-1E was the most preferred option from the surface water perspective. It had the lowest intensity of surface water use of all sites. The downstream water use index was the lowest of all options. Furthermore, there were no potable uses immediately downstream from the site. Flooding constraints with this site were considered to be minor and are easily corrected. The relative factor grouping suitability level was -1.

The partially integrated site LF-1E/PI-27E was ranked second. The comments concerning option LF-1E above also apply to this siting option (with respect to the landfill located on

TABLE 24 DEVELOPMENT OF RELATIVE SUITABILITY RATINGS FOR THE SURFACE WATER SUITABILITY FACTOR GROUPING

RELATIVE SUITABILITY LEVEL	RELATIVE SUITABILITY LEVELS FOR FACTOR		SITING OPTIONS	RATIONALE
	Flooding	Water Use		
-6			None	
-5	-3*	-5	LF-4N/PI-13N	- Water use considered most important factor - constraint is local potable water uses - highest relative level of constraint
-4	-5	-3	LF-3C	- second highest level of constraint - similar to level -3 siting options but more constrained by flood potential
-3	-3 -1	-3 -3	LF-4N/PI-1N LF-9C	- middle level of constraint - flooding differences are not considered to be significant
-2			None	
-1	-1	-1	LF-1E LF-1E/PI-27E	- lowest relative level of constraint - flooding and water use are not concerns

* See Table 22 for development of relative suitability levels for these factors.

TABLE 25 RANKING OF SITING OPTIONS - SURFACE WATER SUITABILITY FACTOR GROUPING

MOST PREFERRED	SITING OPTION	RANKING	FACTOR GROUPING RELATIVE SUITABILITY RATING
	LF-1E	1	-1
	LF-1E/PI-27E	2	-1
	LF-9C	3	-3
	LF-4N/PI-1N	4	-3
	LF-3C	5	-4
LEAST PREFERRED	LF-4N/PI-13N	6	-5

LF-1E). This option was slightly less preferred than LF-1E (integrated) due to minor flood constraints that are associated with site PI-27E. The relative suitability level was -1 (i.e. the same as LF-1E integrated).

Option LF-9C was ranked third. Although this site was considered to have minor constraints from a flooding viewpoint it was considered to have moderate constraints with respect to downstream water uses (moderately high downstream water use index but no potable uses in the site vicinity). This option was rated -3 for relative suitability.

Option LF-4N/PI-1N (partially integrated) was ranked fourth. The water use downstream (as measured by downstream water use index) from this siting option was slightly greater that previous options. No potable uses were identified downstream from these sites. This siting option was considered to be moderately constrained due to flood susceptibility. The flooding concern was with respect to the proximity of the Indian Creek floodplain to site LF-4N; however, these floodlands can be avoided. This siting option received a factor grouping relative suitability rating of -3.

The fifth ranked siting option was LF-3C. This fully integrated siting option was considered to have moderate surface water use constraint similar to option LF-9C (however, more constrained). It was also considered to have major constraints due to flood susceptibility as a result of the proximity of the Beaver Creek and Welland River floodplains. The relative suitability rating for this option was -4.

Option LF-4N/PI-13N was ranked sixth with a relative suitability rating of -5. The main reason for this siting option's low rating was due to the occurrence of potable water uses from streams downgradient from the facilities (PI-13N). These potable uses, coupled with the fact that this site had a high downstream water use index resulted in a high constraint rating for water use. Flooding constraints were associated with LF-4N (discussed previously) and were considered to be avoidable.

The ranking of siting options presented above is based on a set of facility characteristics, assumptions and comparative evaluation methods described previously in this report. To test the sensitivity of the rankings to changes in assumptions and analysis methods a series of analyses were undertaken. These sensitivity analyses are presented in Appendix E.

The sensitivity analysis indicated that the ranking of siting options presented in Table 25 would not change as a result of a change in assumptions concerning total solidification versus evaporation or provision of rail services. The ranking of siting options would change, however, as a result of a change in the comparative evaluation methodology (i.e., the inclusion of the surface water factor in the Transportation Risk factor grouping in the aggregation of factors). The results of the sensitivity analyses were provided to the M.M. Dillon Limited site selection consultants and were considered in the overall combining of factors that led to the ranking of siting options (M.M. Dillon Limited, 1985a).

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

From the findings of the Phase 4A surface water studies presented in the report and its companion Technical Appendix the following conclusions have been made:

1. The basic acceptability analysis indicated that all six siting options were suitable for development of OWMC's facilities from the surface water perspective assuming that our recommended drainage improvement considerations are included in the facility design and layout.

2. The ranking of siting options for the surface water suitability factors, listed in order of most preferred to least preferred was:

   LF-1E
   LF-1E/PI-27E
   LF-9C
   LF-4N/PI-1N
   LF-3C
   LF-4N/PI-13N

3. The sensitivity analysis indicated that the ranking of siting options presented in Table 25 would not change as a result of a change in assumptions concerning total solidification versus evaporation or provision of

rail services. The ranking of siting options would change, however, as a result of a change in the comparative evaluation methodology (i.e., the inclusion of the surface water factor in the Transportation Risk factor grouping in the aggregation of factors).

4.2 RECOMMENDATIONS

During Phase 4B it is recommended that the following surface water studies be undertaken for the preferred site(s) to confirm interpretation of Phase 4A information:

1. Estimates of flood susceptibility should be confirmed through detailed hydrologic and hydraulic analysis to establish engineered floodlines.

2. Detailed surface drainage investigations should be undertaken on the site and in the site vicinity.

3. The surface water use data base should be confirmed and detailed information obtained beyond the site vicinity study area. This information will be necessary to assist in contingency planning and prediction of impacts.

4. Background water quality and quantity data prior to facilities development should be collected to provide a basis for comparison with future monitoring data.

5. Contingency planning and prediction of impact of facility operations on surface water should be undertaken.

6. An analysis of risk should be undertaken for the various surface water pathways. This analysis should address the following:

a) sources of pollution,
b) mode of facility operations,
c) potential pathways such as on-site spills and ground water-surface water connections,
d) contaminant concentration and flow rate,
e) dilution capabilities, flow characteristics and water quality of receiving streams, and
f) downstream water users.

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APPENDIX A

FACTOR SHEETS

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A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS OWMC PHASE 4A

A.1.1 IDENTIFICATION OF PREFERRED ACCESS ROUTES

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	FACTOR:
Risk	Transportation risk to surface water

FACILITY COMPONENTS:
Access Roads

DEFINITION OF FACTOR:
This factor considers the potential risks to human health that may occur as a result of a spill involving vehicles transporting hazardous wastes or reagents along an access route alternative to a waste treatment facility and the possible movement of contaminants to surface waters. This factor was used to identify preferred access routes to the various facility siting options.

RATIONALE/SIGNIFICANCE OF FACTOR:
There is a possibility of an accidental release of hazardous wastes during transit. Surface waters provide a pathway for the rapid movement of contaminants from the spill site. An increased risk to human health and the restriction of use of downstream surface water could occur as a result of a transportation spill.

INTERPRETATION/METHODOLOGY:
Streams that flow adjacent to or cross access routes were identified by means of 1:25,000 scale topographic maps.

The length of access road having a high risk of waste entry to a stream in case of a transportation spill was considered to consist of two components. The first was the floodplain (top-of-bank) as measured directly from 1:25,000 scale topographic maps. The second component was the slightly

A.1.1 IDENTIFICATION OF PREFERRED ACCESS ROUTES

FACTOR GROUPING:	FACTOR:
Risk	Transportation risk to surface water

INTERPRETATION/METHODOLOGY:(cont'd)
sloping land adjacent to the floodplain. This length was calculated by means of standard engineering methods that used information available from 1:25,000 scale topographic maps (e.g. slope) and published sources (e.g. overland flow velocity).

A rating system was developed in consultation with the site selection team to enable comparison of the access routes with respect to the risk to human health and the environment that may occur as a result of an accidental release of contaminants to a surface water system following a transportation spill. The rating system included stream crossing distance and downstream water use components.

INDICATOR #1
The first indicator was the length of access route where there was a high risk of waste entry to a stream should a transportation accident occur (termed the Stream Crossing Distance).

DEFINITION:
The Stream Crossing Distance is the total length of access route where there is a high potential of waste entry to a stream should a transportation spill occur. A large portion of these access route segments occur where the route crosses the floodplains of streams and rivers. If an accident occurs on the floodplain crossing, the potential for waste to enter a stream or river was thought to be high. Sloping segments of routes adjacent to floodplains were also included in the stream crossing distance, although the potential for waste entry to a stream was considered to be less than it would be for accidents occurring on the floodplain.

A.1.1 IDENTIFICATION OF PREFERRED ACCESS ROUTES

FACTOR GROUPING:	FACTOR:
Risk	Transportation risk to surface water

RATIONALE/SIGNIFICANCE:
The potential for contaminant movement to a watercourse in the event of a spill along an access route is directly related to the Stream Crossing Distance.

SOURCES OF INFORMATION:
- 1:25,000 scale topographic maps

INPUTS FROM OTHER CONSULTANTS:
Access route locations from M.M. Dillon Limited Transportation consultants

STUDY AREA:
Access routes

COMMENTS/ASSUMPTIONS/LIMITATIONS:
- Small drainage ditches and swales were not included in the analysis at this study stage.
- It was assumed that waste spills would be in a liquid state of low viscosity and high toxicity.
- It was assumed that an accident or spill involving an OWMC vehicle occurring in a stream crossing segment of an access route would result in waste entering a stream/river before emergency response crews could mitigate the spillage.

INDICATOR #2
Downstream Water Use Index

A.1.1 IDENTIFICATION OF PREFERRED ACCESS ROUTES

FACTOR GROUPING:	FACTOR:
Risk	Transportation risk to surface water

DEFINITION:
This indicator is the sum of the lengths (km) of streams that flow through land uses with sensitive surface water uses, downstream from the access road stream crossings to the ultimate receiver. Land uses with sensitive water use are: rural/agricultural, forested and recreational land use. The indicator was called the Downstream Water Use Index (DSWUI).

STUDY AREA:
The study area consisted of streams downstream from the access roads to the ultimate receiver (Lake Ontario or the Chippawa/Queenston Power Canal).

RATIONALE/SIGNIFICANCE:
This indicator provided a measure of the use of surface water from streams downstream from the access roads. The ultimate receiver was used as the downstream end of the study area. This index was considered to be a surrogate measure of low-volume sensitive water uses. The index measures stream lengths through land uses that are likely to support low volume (i.e. do not need an MOE Permit To Take Water) or diffuse (livestock watering, recreational) users which may consume or contact surface water.

Urban and industrial land uses were not considered to have the same sensitive users and consequently were not used for the compilation of the index.

The index provided a qualitative measure of sensitive water use in the regional study area where detailed information on local water uses was not available.

SOURCES OF INFORMATION:
- 1:25,000 scale topographic maps, MOE Permit to Take Water Files, OWMC Phase 3 Reports (GLAL)

A.1.1 IDENTIFICATION OF PREFERRED ACCESS ROUTES

FACTOR GROUPING:	FACTOR:
Risk	Transportation risk to surface water

COMMENTS/ASSUMPTIONS/LIMITATIONS:
Within the site vicinity specific identification of minor water uses was undertaken during the walk-and-talk program. Downstream from the access roads it was decided to use a less detailed but more extensive technique to gauge surface water use. The DSWUI was considered adequate for identifying preferred access routes.

A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.1.2 IDENTIFICATION OF RAIL ACCESS ROUTES - SCREENING

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	**FACTOR:**
Impact	Number of stream crossings

FACILITY COMPONENTS:
Rail Access Routes

DEFINITION OF FACTOR:
This factor was designed to account for the proximity of a rail access route to streams or watercourses and assist in the identification of rail access alternatives to sites.

RATIONALE/SIGNIFICANCE:
Watercourses could provide a pathway for the rapid movement of reagents in the event of rail accidents which could result in environmental damage. In addition to streams, areas of land covered by Regional Storm Floodplains and other flood prone areas were considered to be susceptible water bodies. It was desirable to choose rail alignments that avoided or minimized the number of stream crossings.

INTERPRETATION/METHODOLOGY:
Maps were prepared at 1:10,000 scale showing streams, floodplains and other flood-prone areas. The rail access corridors under consideration were overlain on the maps and the number of stream crossings counted.

SOURCES OF INFORMATION:
- 1:10,000 scale topographical maps
- aerial photography (1978, 1984; 1:10,000 scale)

INPUTS FROM OTHER CONSULTANTS:
Rail access corridors from M.M. Dillon-Transportation.

A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.1.3 IDENTIFICATION OF RAIL ACCESS ROUTES DETAILED COMPARATIVE EVALUATION

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	**FACTOR:**
Impact	Number of stream crossings

FACILITY COMPONENTS:
Rail Access Routes

DEFINITION OF FACTOR:
This factor was designed to account for the proximity of a rail access route to streams or watercourses and assist in the identification of preferred rail access alternatives to sites.

RATIONALE/SIGNIFICANCE:
Watercourses could provide a pathway for the rapid movement of reagents in the event of a rail accident, and result in environmental damage. In addition to streams, areas of land covered by Regional Storm Floodplains and other flood-prone areas were considered as susceptible water bodies. It was desirable to choose rail alignments that avoided or minimized the number of stream crossings.

INTERPRETATION/METHODOLOGY:
Maps were prepared at 1:10,000 scale showing streams, floodplains and other flood-prone areas. The rail access corridors under consideration were overlaid on the maps and the number of stream crossings counted.

SOURCES OF INFORMATION:
- 1:10,000 scale topographical maps
- aerial photography (1978, 1984; 1:10,000 Scale)

INPUTS FROM OTHER CONSULTANTS:
Rail access corridors from M.M. Dillon-Transportation

A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.1.3 IDENTIFICATION OF RAIL ACCESS ROUTES DETAILED COMPARATIVE EVALUATION

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	**FACTOR:**
Impact	Proximity to floodplains and flood-prone areas

FACILITY COMPONENTS:
Rail Access Routes

DEFINITION OF FACTOR:
The proximity to Regional Storm Floodplains and Flood-prone Areas Factor considers potential sources of flooding and runoff (e.g. local drainage, back-up from receiving streams and/or runoff generated from an upstream drainage area passing through the rail access corridor).

RATIONALE AND SIGNIFICANCE:
Where available from Conservation Authorities, Regional Storm Floodplains designated in accordance with the accepted provincial standard (Regional Flood), and an air photo interpretation were used to define flood-prone areas on or in the vicinity of the rail access corridor. This information was used to estimate the potential for flooding of the rail access corridor.

INDICATOR #1
Regional Storm Floodplains and Flood-prone Areas

A.1.3 IDENTIFICATION OF RAIL ACCESS ROUTES - DETAILED COMPARATIVE EVALUATION

FACTOR GROUPING:	FACTOR
Impact	Proximity to floodplains and flood-prone areas

DEFINITION:
Designated Regional Storm Floodplains are those identified by the Conservation Authority as being inundated under the Regulatory Flood (i.e. Regional Storm or 100 year return period storm, whichever is greater).

Flood-prone areas are lands subject to periodic flooding. These areas often show evidence of wet surface conditions or poor drainage and can be identified by stereoscopic interpretation of aerial photographs. No rail access corridor should be located on Regional Storm Floodplains or flood-prone lands.

STUDY AREA:
Rail Access Corridors

Notes: - 1. There may be construction phase effects.
2. Mitigation is possible.

RATIONALE AND SIGNIFICANCE:
Accurate floodplain delineation (e.g. as designated by Conservation Authorites) involves the use of analytical or statistical methods to determine design flows, together with accurate definition of the flow conveyance system and preparation of maps. No component of the rail access corridor should be located on designated floodplain lands.

A.1.3 IDENTIFICATION OF RAIL ACCESS ROUTES - DETAILED COMPARATIVE EVALUATION

FACTOR GROUPING:	FACTOR
Impact	Proximity to floodplains and flood-prone areas

SOURCES OF INFORMATION:

- available floodplain mapping prepared by Conservation Authority
- flood-prone area identification by airphoto interpretation at 1:10,000 scale prepared by GLAL for Phase 3 work
- aerial photography (1978 and 1984; 1:10,000 scale)
- discussions with Ministry of the Environment, Conservation Authorities, and interviews with local residents to identify areas prone to flooding and the frequency of occurrence

COMMENTS/ASSUMPTIONS/LIMITATIONS:

Floodplain mapping prepared by Conservation Authorities was not available for many of the streams draining the candidate sites.

A preliminary indication of flood susceptibility was provided in Phase 4A using existing airphoto interpretation and floodplain mapping. Detailed floodplain delineation will be undertaken in Phase 4B.

A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.1.4 SITE BOUNDARY REFINEMENT

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	**FACTOR:**
Risk	Flood susceptibility

FACILITY COMPONENTS:
LF-1E, LF-3C and PI-1N

DEFINITION OF FACTOR:
The site flooding factor considers all potential sources of site flooding including runoff generated on site and off-site. (e.g. local site drainage, back-up from receiving steams and/or runoff generated from an upstream drainage area passing through the site).

RATIONALE AND SIGNIFICANCE:
Flooding of an occupied portion of a waste treatment facility creates the potential for disruption of site operations and the potential for transport of contaminants off-site into receiving waters with the associated risk to human health and the environment depending on downstream water uses. No component of a waste treatment facility should be located on a Regional Storm Floodplain or flood-prone area.

INTERPRETATION/METHODOLOGY:
Where available from Conservation Authorities, Regional Storm Floodplains designated in accordance with the accepted provincial standard (Regional Flood) were used to define flood-prone areas on or in the vicinity of sites.

A.1.4 SITE BOUNDARY REFINEMENT

FACTOR GROUPING:	FACTOR:
Risk	Flood susceptibility

INTERPRETATION METHODOLOGY: (cont'd)
For very small drainage areas and minor watercourses on the sites, preliminary estimates of peak runoff was generated at the site boundries, using the Rational Method, for a range of meteorological events (e.g. 5, 10, 50 and 100 year return period storms). The Regional Storm is not generally the storm which generates the Regulatory Flood for very small drainage areas. Runoff for storms having return periods of up to 100 years is generally an adequate indication of flood risk for small watercourses.

Potential for flooding on-site was estimated for available floodplain interpretation and on the basis of runoff potential relative to apparent conveyance capacity. The approximate depth of flooding in the vicinity of outlet culverts/bridges was determined for storm events of varying return periods. This information was then mapped and used to identify flooding constraints on the sites.

SOURCES OF INFORMATION:
- available floodplain mapping prepared by Conservation Authorities
- identification of flood-prone areas by airphoto interpretation at 1:10,000 scale prepared by GLAL for Phase 3 work;
- aerial photography (1978 and 1984; 1:10,000 scale);
- discussions with Ministry of the Environment, Conservation Authorities, and interviews with local residents to identify areas prone to flooding and the frequency of occurrence.

COMMENTS/ASSUMPTIONS/LIMITATIONS:
Floodplain mapping prepared by Conservation Authorities was not available for many of the streams draining the candidate sites.

A preliminary indication of flood susceptibility was provided in Phase 4A using existing air photo interpretation of floodplain mapping in conjunction with preliminary estimates of runoff potential and outlet capacity. Detailed floodplain delineation will be undertaken in Phase 4B.

A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.1.4 SITE BOUNDARY REFINEMENT

LEAD CONSULTANT
Gartner Lee Associates Limited

FACTOR GROUPING:	FACTOR:
Risk	Downstream water use

FACILITY COMPONENTS:
LF-1E, LF-3C AND PI-1N

DEFINITION OF FACTOR:
This factor considers the number of watersheds draining each site and the number of different directions that runoff would leave a site. This provides a measure of the extent of surface water resources (and hence uses) that might potentially be affected by the facility.

RATIONALE AND SIGNIFICANCE:
The objective is to reduce or minimize the number of watersheds draining a site so that in the event of migration off-site of contaminated water the potentially effected geographic area would be minimized. Mitigation and cleanup of such off-site migration would be easier if the effects are contained within a limited number of watersheds, downstream from the site.

INTERPRETATION/METHODOLOGY:
The watershed divides were completed for each site based on the interpretation of 1:10000 scale air photography and field inspections. Ground slopes and runoff flow directions were derived to determine the watershed for each outlet culvert, and other areas where the runoff flowed from the site.

A.1 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.1.5 LOCATION OF PHYSICAL-CHEMICAL TREATMENT PLANT FOR PARTIALLY INTEGRATED SITING OPTIONS

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	**FACTOR:**
Impact	Surface Water Suitability

FACILITY COMPONENTS:
All components

DEFINITION OF FACTOR:
The surface water suitability factor consists of one indicator, i.e. a spill pathway index.

RATIONALE/SIGNIFICANCE OF FACTOR:
Streams and watercourses along an access route represent pathways for the quick movement of liquid waste and/or reagents into the local stream network in the event of a spill in the vicinity of a stream crossing.

Because different options have different locations for the physical/chemical plant and the incinerator the volume and type of waste carried along any link of an access road will depend on what part of the facility the access serves. Similarly the number of vehicle movements on a particular link of an access road will depend on the facility served by the road.

The Spill Pathway Index (SPI) was designed to account for different numbers of vehicle movements of different types of load over links of access roads with different numbers of stream crossings. The SPI was developed to assist in the identification of preferred physical-chemical treatment plant location for partially integrated siting options, i.e. with the incinerator (separate landfill) or with the landfill (separate incinerator).

A.1.5 LOCATION OF PHYSICAL/CHEMICAL TREATMENT PLANT FOR PARTIALLY INTEGRATED SITING OPTIONS

FACTOR GROUPING:	FACTOR
Impact	Surface Water Suitability

INTERPRETATION/METHODOLOGY:
The option with the lower SPI was preferable because it reflected a siting arrangement that would result in the numbers of vehicle movements of hazardous wastes across streams being minimized.

INDICATOR #1
Spill Pathway Index (SPI)

DEFINITION:
The spill pathway index is a composite numerical index related to the expected rate of in-transit spill events by OWMC vehicles (through an accidental or other loss of containment), the type of commodity carried (waste, reagents and additives or inter-site transfer material) and the proportion of an access road where there is a relatively high level risk that a spillage of waste would enter a stream.

RATIONALE/SIGNIFICANCE:
The likelihood of a contaminant being released to the environment along the access roads is directly related to the frequency of "losses of containment" of an OWMC vehicle. The index acknowledges the different types of commodities carried by OWMC vehicles. Wastes have a weighting of ten. Additives and reagents, and intersite transfers have a weighting of one, each. The likelihood of contaminant movement to a watercourse in the event of a spill is directly related to the Stream Crossing Distance. Stream Crossing Distance is expressed as a

A.1.5 LOCATION OF PHYSICALLY/CHEMICAL TREATMENT PLANT FOR PARTIALLY INTEGRATED SITING OPTIONS

FACTOR GROUPING:	FACTOR:
Impact	Surface water suitability

RATIONALE/SIGNIFICANCE: (cont'd)
proportion of each link length to account for the proportion of access roads where there is a high risk of contaminant movement to a stream. The SPI was jointly developed with the Dillon Transportation consultant. The weighting factor for wastes was provided by the Environ-Risk consultant.

SOURCES OF INFORMATION:
- 1:25,000 scale topographical mapping

INPUTS FROM OTHER CONSULTANTS:
Access route locations from M.M. Dillon Limited Transportation. Calculations of Spill Pathway Index by M.M. Dillon Limited Transportation.

STUDY AREA:
Access roads

COMMENTS/ASSUMPTIONS/LIMITATIONS:
- Small drainage ditches and swales were specifically identified and not included in the analysis. The critical overland flow value was used to account for the flow of spilled wastes along the road surface and in roadside ditches.
- It was assumed that some wastes being transported are in a liquid state and of low viscosity.
- It was assumed that a spill event involving an OWMC vehicle occurring within a stream crossing segment of an access route will result in waste entering a stream/river before emergency response crews can mitigate the spillage.

A.2 FACTORS USED IN REFINEMENT OF SITING OPTIONS - OWMC PHASE 4A

A.2.1 SURFACE WATER SUITABILITY (RISK)

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	**FACTOR:**
Surface water suitability (Risk)	Susceptibility of the site to flooding

FACILITY COMPONENTS:
All Facility Components

DEFINITION OF FACTOR:
The site flooding factor considers potential sources of site flooding including runoff generated on-site and off-site. (e.g. local site drainage, back-up from receiving streams and/or runoff generated from an upstream drainage area passing through the site).

RATIONALE AND SIGNIFICANCE:
Flooding of an occupied portion of a waste treatment facility creates the potential for disruption of site operations and the potential for transport of contaminants off-site into receiving waters with the associated risk to human health for downstream water uses.

INTERPRETATION/METHODOLOGY:
Where available from Conservation Authorities, Regional Storm Floodplains designated in accordance with the accepted provincial standard (Regional Flood) were used to define flood-prone areas on or in the vicinity of sites. This information was used to establish the potential for back-up of water onto the sites from downstream.

A.2.1 SURFACE WATER SUITABILITY

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Susceptibility of the site to flooding

INTERPRETATION/METHODOLOGY: (cont'd)

For very small drainage areas and minor watercourses on the sites, preliminary estimates of peak runoff was generated at the site boundaries, using the Rational Method, for a range of meteorological events (i.e. 5, 10, 50 and 100 year return period storms). The Regional Storm is not generally the storm which generates the Regulatory Flood for very small drainage areas. Runoff for storms having return periods of up to 100 years is generally an adequate indication of flood risk for small watercourses.

Potential for flooding on-site was estimated from available floodplain interpretation and on the basis of runoff potential relative to apparent conveyance capacity. The approximate depth of flooding in the vicinity of outlet culverts/bridges was determined for storm events of varying return periods.

INDICATOR #1
Designated Floodplains and Flood-prone Areas

DEFINITION:
Designated Regional Storm Floodplains are those identified by a Conservation Authority as being inundated under the Regulatory Flood (i.e. Regional Storm or 100 year return period storm, whichever is greater).

Flood-prone areas are lands subject to periodic flooding. These areas often show evidence of wet surface conditions or poor drainage and can be identified by stereoscopic interpretation of aerial photographs. No facility components should be located on Regional Storm Floodplains or flood-prone lands.

A.2.1 SURFACE WATER SUITABILITY

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Susceptibility of the site to flooding

STUDY AREA:
Site
Notes: 1. There may be construction phase effects
2. Mitigation is possible

RATIONALE AND SIGNIFICANCE:
Accurate floodplain delineation (e.g. as designated by Conservation Authorities) involves the use of analytical or statistical methods to determine design flows, together with accurate definition of the flow conveyance system and preparation of maps. No component of the waste treatment facility should be located on designated floodplain lands.

SOURCES OF INFORMATION:
- available floodplain mapping prepared by Conservation Authorities
- identification of flood-prone areas through airphoto interpretation at 1:10,000 scale prepared by GLAL for Phase 3 work
- aerial photography (1978 and 1984; 1:10,000 scale);
- discussions with Conservation Authorities, and interviews with local residents to identify areas prone to flooding and the frequency of occurrence.

COMMENTS/ASSUMPTIONS/LIMITATIONS:
Floodplain mapping prepared by Conservation Authorities was not avaialble for many of the streams draining the candidate sites.

A preliminary indication of flood susceptibility was provided in Phase 4A using existing air photo interpretation or floodplain mapping in conjunction with preliminary estimates of runoff potential and outlet capacity. Detailed floodplain delineation will be undertaken in Phase 4B.

A.2.1 SURFACE WATER SUITABILITY

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Susceptibility of the site to flooding

INDICATOR #2
Runoff Potential

DEFINITION:
Runoff potential relates to small drainage areas and minor watercourses on the sites. It is considered to be the peak runoff generated at the site for a range of possible meteorological events such as the 5, 10, 50 and 100 year return period storms.

STUDY AREA:
Site and Site Vicinity

Notes:
1. There may be postconstruction phase effects.
2. Mitigation is possible

RATIONALE AND SIGNIFICANCE:
Runoff potential forms the basis for estimating adequacy of existing outlet culverts/bridges and for determining the approximate depth of flooding at these outlets.

SOURCES OF INFORMATION:
- Surface Water Data - Ontario (various periods), Environment Canada, Inland Waters Directorate;
- published and unpublished stream flow data collected by Ontario Ministry of the Environment, Water Resources Branch, Central and West Central Regions, and Conservation Authorities;
- Canadian Climatic Normals - Temperature and Precipitation - Ontario, published by Atmospheric Environment Service;
- selected rainfall intensity-duration-frequency data published by Atmospheric Environment Service;
- land use and cropping practices compiled by Ecologistics.

A.2.1 SURFACE WATER SUITABILITY

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Susceptibility of the site to flooding

COMMENTS/ASSUMPTIONS/LIMITATIONS:
Estimated runoff potential relates to pre-construction land use, topography and vegetation conditions.

INDICATOR #3
Conveyance Capacity

DEFINITION:
The volume of flow that can be conveyed by a bridge or culvert without back-up of water onto the sites is termed 'conveyance capacity'.

STUDY AREA:
Site and Site Vicinity
Notes: 1. Mitigation is possible.

RATIONALE AND SIGNIFICANCE:
Comparison of the capacity of culverts/bridges which convey runoff off-site with watershed runoff potential will permit approximation of the depth of flooding upstream of the structure for various return period events. Structures that are frequently over-topped may need replacement.

SOURCES OF INFORMATION:
- field trips to the sites and surrounds to verify and obtain additional information on floodplain characteristics, cropping practices, channel geometry, sizes of outlet culverts/bridges, and apparent flow restrictions.

COMMENTS/ASSUMPTIONS/LIMITATIONS:
Estimated flood levels relate to pre-construction land use, vegetation conditions and existing outlet structures.

A.2 FACTORS USED IN COMPARISON OF SITING OPTIONS - OWMC PHASE 4A

A.2.1 SURFACE WATER SUITABILITY (RISK)

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Potential for downstream water use interference

FACILITY COMPONENTS:
All Facility Components

DEFINITION OF FACTOR:
Existing and potential sensitive uses of surface waters are included in this factor. The main risk to human health would be through the use of contaminated surface waters for potable water supply.

RATIONALE AND SIGNIFICANCE:
A waste treatment facility has the potential to interfere with downstream use of surface waters by causing a risk to human health should any of the following occur: accidental discharge of contaminated water from a facility site or accidental spills on a facility site.

INTERPRETATION/METHODOLOGY:
Surface water uses were identified and plotted on 1:50,000 scale regional maps and 1:10,000 scale maps of the candidate sites and vicinities. Information such as the user name and type of use were depicted. A qualitative assessment of the potential for interference with sensitive uses by a waste treatment facility was undertaken on a regional scale where downstream water use (DSWUI) was developed and used for this purpose.

A.2.1 SURFACE WATER SUITABILITY (RISK)

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Potential for downstream water use interference

INDICATOR #1
Downstream Water Use Index

DEFINITION:
This indicator is the sum of the lengths (km) of streams that flow through land uses thought most likely to support sensitive surface water uses, downstream from the projected storm water outfall to the ultimate receiver. Land uses with sensitive water use are: rural/agricultural, forested and recreational land use.

STUDY AREA:
The study area was considered to be watercourses downstream from the projected storm water outfall to an ultimate receiver (Lake Ontario or the Chippawa/Queenston Power Canal).

Because all of the stormwater from a facility will be flowing from one outfall the projected outfall location was used as the upstream end of the study area. The ultimate receiver was used as the downstream end of the study area.

RATIONALE AND SIGNIFICANCE:
This indicator was considered to be a surrogate measure of sensitive low volume use of surface water downstream from the site.

SOURCES OF INFORMATION:
- 1:25,000 scale Topographic maps.

COMMENTS/ASSUMPTIONS/LIMITATIONS:
It was assumed that agricultural/rural, forested and recreational land uses represented the potential for low-volume sensitive water use that could represent a contaminant pathway to humans and hence, a health risk. Within the site vicinity, site specific counting of water use was undertaken during the walk-and-talk program.

A.2.1 SURFACE WATER SUITABILITY (RISK)

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Potential for downstream water use interference

COMMENTS/ASSUMPTIONS/LIMITATION: (cont'd)
Downstream from the site vicinity detailed local water use information was not available, therefore, it was decided to use a less detailed but more extensive technique to gauge surface water use. The compilation of the DSWUI was considered an effective technique for measuring downstream water use within the regional scale study area and provided a basis for the relative comparison of siting options.

INDICATOR #2
Number of local stream takings for potable supply

DEFINITION:
This indicator is the number of locations where stream water was taken for potable supplies i.e. household drinking water.

STUDY AREA:
The study area was considered to be watercourses downstream from the projected stormwater outfall within the site vicinity.

RATIONALE/SIGNIFICANCE:
This indicator is a measure of the potential risk to human health from consumption of surface water (streams) by humans. If a spill or other source should result in a migration of contaminated water off-site via the stormwater system, then these consumers would be placed at risk relatively quickly because of their use of potable surface water. Although it may be possible to warn downstream users of potential contamination, the close proximity of these sensitive uses to the stormwater outfall was considered to be a potential risk.

A.2.1 SURFACE WATER SUITABILITY (RISK)

FACTOR GROUPING:	FACTOR:
Surface water suitability (Risk)	Potential for downstream water use interference

SOURCES OF INFORMATION:

- The primary source of information was the house-to-house interviews of the walk-and-talk program. During the interview respondents were asked to identify their sources of potable water. Supplementary information came from data volunteered by members of the public as a result of the meetings associated with the walk-and-talk program.

COMMENTS/ASSUMPTIONS/LIMITATIONS:

The study area is limited to the site vicinity because the walk-and-talk data collection process was limited to the site and site vicinity. Only consumers in the watershed downstream from the projected stormwater outfall were counted because those upstream should not be effected and those in other watersheds will not have any stormwater from the facility flowing past their intakes. The stormwater drainage system should be designed so that all of the stormwater from the facility should flow from only one outfall.

A.2 FACTOR USED IN COMPARISON OF SITING OPTIONS - OWMC PHASE 4A

A.2.2 TRANSPORTATION RISK

LEAD CONSULTANT:
Gartner Lee Associates Limited

FACTOR GROUPING:	FACTOR:
Transportation (Risk)	Surface water suitability

FACILITY COMPONENTS:
Access Routes

DEFINITION OF FACTOR:
This factor considers the potential risks to human health that may occur as a result of a spill event involving vehicles transporting hazardous wastes and reagents along an access corridor to a waste treatment facility and the possible movement of contaminants to surface waters.

RATIONALE/SIGNIFICANCE OF FACTOR:
There is a possibility of an accidental release of hazardous wastes during transit. Surface waters provide a pathway for the rapid movement of contaminants from the spill site. Environmental damage, an increased risk to human health and the restriction of downstream surface water uses are indicators of the relative significance of this factor.

INTERPRETATION/METHODOLOGY:
Streams that flow adjacent to or cross access routes were identified by means of 1:25,000 scale topographic maps.

The length of access road having a high risk of waste entry to a stream in case of a transportation accident was considered to consist of two components. The first was the floodplain (top-of-bank) and was measured directly from 1:25,000 scale topographic maps. The second component (critical overland flow length) was the slightly sloping

A.2.2 TRANSPORTATION RISK

FACTOR GROUPING:	FACTOR:
Transportation (Risk)	Surface water suitability

INTERPRETATION/METHODOLOGY: (cont'd)
land adjacent to the floodplain. This length was calculated by means of standard engineering methods that used information available from 1:25,000 scale topographic maps (e.g. slope) and published sources (e.g. overland flow velocity). This component was included to provide an additional measure of safety and to account for worst case situations such as a spill during a rainstorm where spilled wastes could travel along roadside ditches.

A rating system was developed to enable comparison of the access routes with respect to the risk to human health that may occur as a result of an accidental release of contaminants to a surface water system following a transportation spill. The rating system included spill pathway index and downstream water use index.

INDICATOR #1
Spill Pathway Index (SPI)

DEFINITION:
The spill pathway index is a composite numerical index related to the expected rate of in-transit spill events by OWMC vehicles (through an accidental or other loss of containment), the type of commodity carried (waste, reagents and additives or inter-site transfer material) and the proportion of an access road where there is a relatively high level risk that a spillage of waste would enter a stream.

RATIONALE/SIGNIFICANCE:
The likelihood of a contaminant being released to the environment along the access roads is directly related to the frequency of "losses of containment" of an OWMC vehicle. The index acknowledges the different types of commodities carried by OWMC vehicles. Wastes have a weighting of ten. Additives and reagents, and intersite transfers have a weighting of one, each. The likelihood of contaminant movement to a watercourse in the event of a spill is directly related to the Stream Crossing Distance. Stream Crossing Distance is expressed as a

A.2.2 TRANSPORTATION RISK

FACTOR GROUPING:	FACTOR:
Transportation (Risk)	Surface water suitability

RATIONALE/SIGNIFICANCE: (cont'd)
proportion of each link length to account for the proportion of access roads where there is a high risk of contaminant movement to a stream. The SPI was jointly developed with the Dillon Transportation consultant. The weighting factor for wastes was provided by the Environ-Risk consultant.

SOURCES OF INFORMATION:
- 1:25,000 scale topographical mapping.

INPUTS FROM OTHER CONSULTANTS:
Access route locations from M.M. Dillon Limited Transportation consultant. Calculations of Spill Pathway Index by M.M. Dillon Limited Transportation consultant.

STUDY AREA:
Access roads

COMMENTS/ASSUMPTIONS/LIMITATIONS:
- Small drainage ditches and swales were specifically identified and not included in the analysis. The critical overland flow value was used to account for the flow of spilled wastes along the road surface and in roadside ditches.
- It was assumed that some wastes being transported are in a liquid state and of low viscosity.
- It was assumed that a spill event involving an OWMC vehicle occurring within a stream crossing segment of an access route will result in waste entering a stream/river before emergency response crews can mitigate the spillage.

A.2.2 TRANSPORTATION RISK

FACTOR GROUPING:	FACTOR:
Transportation (Risk)	Surface water suitability

INDICATOR #2
Downstream Water Use Index (DSWUI)

DEFINITION:
This indicator is the sum of the lengths (km) of streams that flow through land uses with sensitive surface water uses, downstream from the access road stream crossings to the ultimate receiver. Land uses with sensitive water were considered to be rural/agricultural, forested and recreational land use.

STUDY AREA:
The study area was considered to be streams downstream from the access roads to the ultimate receiver (Lake Ontario or the Chippawa/Queenston Power Canal).

RATIONALE AND SIGNIFICANCE:
This indicator was used to measure the use of surface water from streams downstream from the access roads. This technique was considered to be a surrogate measure of the extent of of surface water that would be sensitive to contamination.

The DSWUI measures stream lengths through land uses that are likely to support low volume (i.e. do not need an MOE Permit To Take Water) or diffuse (livestock watering, recreational) uses which may come in contact with the surface water.

Urban and industrial land uses were not considered to have the same sensitive use and consequently were not used for the compilation of the index.

A.2.2 TRANSPORTATION RISK

FACTOR GROUPING:	FACTOR:
Transportation (Risk)	Surface Water Suitability

RATIONALE AND SIGNIFICANCE: (cont'd)
Within the site vicinity specific counting of water use was undertaken during the walk-and-talk program. Downstream from the access roads local water use information was not available therefore it was decided to use a less detailed but more extensive technique to gauge surface water use. The compilation of the DSWUI was considered to be a suitable technique for evaluating access route alternatives.

SOURCES OF INFORMATION:
- 1:25,000 scale topographic maps

COMMENTS/ASSUMPTIONS/LIMITATIONS:
It was assumed that agricultural/rural, forested and recreational land uses represented the potential for low-volume sensitive water uses that could represent a contaminant pathway to humans and hence a health risk.

APPENDIX B

DATA INTERCHANGE AMONG CONSULTANTS

TABLE B.1 DATA INTERCHANGE AMONG CONSULTANTS

DATA INPUT	PREPARED BY:	PROVIDED TO:	USED FOR
• Drainage Improvement Characteristics	GLAL	Monenco	Cost Analysis
• Ponds and Cistern Uses	GLAL	ORF and Environ	Air pathway risk assessment
• Surface Water Uses (agriculture)	Ecologistics	GLAL	Surface water use risk evaluation
• Tile Drainage Information	Ecologistics	GLAL	Drainage improvements analysis
• Stream Crossing Distances	GLAL	M.M.Dillon -Transportation	Input to calculation of Spill Pathway Index and Transportation analysis

APPENDIX C

SCREENING OF INITIAL FACTORS AND INDICATORS - RATIONALE

TABLE C.1 SCREENING OF INITIAL FACTORS AND INDICATORS-RATIONALE

FACTOR/INDICATOR/RATIONALE	STATUS
1. Susceptibility of Site to Flooding	Applied
a) Designated floodplains and flood-prone areas	Applied
This indicator provides a direct measure of flood susceptibility, e.g. Regional Storm Floodplains identified by standard engineering methods and flood-prone areas estimated by air photograph interpretation.	
b) Runoff potential	Applied
This indicator provides a measure of the peak flow that can be expected from drainage areas on-site and upstream from the site, and assists in the determination of flood susceptibility.	
c) Conveyance capacity	Applied
This indicator provides a measure of the adequacy of downstream outlets to convey flows through and away from the sites to an adequate receiving body without flooding. The indicator assists in the determination of flood susceptibility.	
2. Potential for Water Use Interference	Applied
a) Downstream water use	Modified and Applied
Downstream water use is a measure of the significance of downstream "receptors" should contaminants enter the surface water "pathways" as a result of engineering failure during construction, operational and post operational phases.	
This indicator was split into two new indicators: Downstream Water Use Index and Number of Local Stream Takings for Potable Supply.	

TABLE C.1(Cont'd)

FACTOR/INDICATOR/RATIONALE	STATUS
Potential for Water Use Interference (cont'd)	
The downstream Water Use Index indicator covers downstream reaches of streams for which no specific water use data were collected. Land use as measured from 1:25,000 scale topographic maps was used as an indirect measure of sensitive water use. Streams running through rural, wooded and recreational lands are more likely to be used for potable, domestic (non-potable) and agricultural uses (all considered to be sensitive uses). The Number of Local Stream Takings for Potable Supply indicator consisted of the number of withdrawals in the local downstream study area for potable uses. The local downstream study area consisted of watercourses downstream from the stormwater drainage discharge point to the boundary of the site vicinity study area.	
3. Transportation Risk to Surface Waters	Applied
a) Spill pathway index	Applied
Provides a quantitative measurement of stream crossings at risk from a transportation spill. Better than simply counting stream crossings because this indicator reflects physical conditions that would contribute to contaminant movement to streams following a transportation spill (e.g. floodplain width, overland slope) Stream crossing distance was combined with the hazard based spill index provided by the transportation consultant to produce a spill pathway index which is a measure of the likelihood of spilled wastes entering a watercourse.	

TABLE C.1 (Cont'd)

FACTOR/INDICATOR/RATIONALE	STATUS
Transportation Risk to Surface Waters (cont'd)	
b) Downstream water use index Provides a qualitative measurement of the significance of the receptors to this pathway for contaminant movement. Based on the surrogate measure of stream length through sensitive land uses.	Applied

APPENDIX D

DATA MATRICES

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TABLE D.1

SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

1. **DESIGNATED FLOODPLAINS AND FLOOD-PRONE AREAS INDICATOR**

SITING OPTION	DATA/FINDINGS
LF-3C	- substantial flood-prone area along Beaver Creek; northern part of site is designated floodplain land (Welland River backwater) - small designated floodplain areas (Welland River) along southern boundary of site - uncertainty associated with flood line of Beaver Creek - engineering measures (e.g. berms) may be required to provide additional level of flood protection
LF-9C	- none of site designated floodplain land - no flood-prone area (on-site) identified from air photo interpretation - numerous low lying depressions (swamp areas) on site - easily drained
LF-1E	- minor flood-prone area reported along Carl Road/Morris Road intersection - no designated flood-prone areas on site

TABLE D.1 (Cont'd)

SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

1. DESIGNATED FLOODPLAINS AND FLOOD-PRONE AREAS INDICATOR

SITING OPTION	DATA/FINDINGS
LF-1E/PI-27E	LF-1E - minor flood-prone area reported along Carl Road/Morris Road intersection - no designated floodplains on site PI-27E - minor flood-prone areas along Grassy Brook and Lyons Creek tributary - no designated floodplains on site
LF-4N/PI-13N	LF-4N - small areas in the southwest and northwest corners of site are designated floodplain land PI-13N - minor flood-prone areas on southeast and southwest corners of the site - none of site designated floodplain lands
LF-4N/PI-1N	LF-4N - small areas in the southwest and northwest corners of site are designated floodplain land PI-1N - minor flood-prone area along swale on east side of site which outlets beneath Hwy 25 - none of site designated floodplain lands

TABLE D.1 (Cont'd)

SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

2. RUNOFF POTENTIAL INDICATOR

SITING OPTION	DATA/FINDINGS
LF-3C	- total upstream drainage area conveyed through site is 2,030 ha* approximately
LF-9C	- total upstream area draining through site is about 10 ha
LF-1E	- total upstream area draining through site is 0 ha
LF-1E/PI-27E	- total upstream area draining through LF-1E is 0 ha. - flooding constraint for this siting option is associated with PI-27E - total upstream area draining through site PI-27E is approximately 1,880 ha
LF-4N/PI-13N	- upstream drainage area for LF-4N is 0 ha - upstream drainage area for PI-13N is approximately 56 ha
LF-4N-PI-1N	- upstream drainage area for LF-4N is 0 ha - upstream drainage area for PI-1N is approximately 570 ha

* Drainage area estimates have been rounded to the nearest 10 ha.

TABLE D.1 (Cont'd)

SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

3. CONVEYANCE CAPACITY INDICATOR

SITING OPTION	DATA/FINDINGS
LF-3C	- Beaver Creek slope is very mild - backwater conditions from the Welland River - upgrading of bridge capacity may be necessary
LF-9C	- outlet slopes have adequate slopes but are not well defined - outlet swale capacity is judged to be inadequate and upgrading recommended
LF-1E	- outlet slopes have very mild slope - site flooding due to insufficient downstream swale capacity is likely - upgrading recommended
LF-1E/PI-27E	LF-1E - outlet slopes have very mild slope - site flooding due to insufficient downstream swale capacity is likely - upgrading recommended PI-27E - outlet channels have very mild slope - site flooding due to insufficient swale capacity likely, upgrading recommended

TABLE D.1 (Cont'd)

SUSCEPTIBILITY OF SITE TO FLOODING FACTOR

3. **CONVEYANCE CAPACITY INDICATOR**

SITING OPTION	DATA/FINDINGS
LF-4N/PI-13N	LF-4N - outlet swales mild, but have sufficient slope for conveying runoff off-site PI-13N - flooding of site due to insufficient downstream swale capacity possible for LF-4N but not likely for PI-13N
LF-4N/PI-1N	LF-4N - outlet swales just have sufficient slope for conveying runoff off-site - conveyance capacity constraints associated with LF-4N PI-1N - outlet swales generally have adequate slope and downstream capacity

TABLE D.2

POTENTIAL FOR WATER USE INTERFERENCE FACTOR

SITING OPTION	DOWNSTREAM WATER USE INDEX*	NUMBER OF LOCAL STREAM TAKINGS FOR POTABLE SUPPLY
LF-3C	43	0
LF-9C	36	0
LF-1E	14	0
LF-1E/PI-27E	15	0
LF-4N/PI-13N	40	2
LF-4N/PI-1N	36	0

* Rounded to nearest integer

TABLE D.3

TRANSPORTATION RISK-SURFACE WATER SUITABILITY FACTOR

SITING OPTION	SPILL PATHWAY INDEX*	DOWNSTREAM WATER USE INDEX **
LF-3C	1.52	940
LF-9C	1.21	330
LF-1E	0.00	0
LF-1E/PI-27E	0.00	0
LF-4N/PI-13N	0.58	540
LF-4N/PI-1N	0.72	420

* Rounded to two decimal places. Data inputs provided by Dillon (1985B)

**Rounded to nearest ten.

APPENDIX E

SENSITIVITY ANALYSES

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E.1 INTRODUCTION

The ranking of siting options presented in Section 3.9 is based on a set of facility characteristics, assumptions and comparative evaluation methods described in earlier sections of the report. To test the sensitivity of the rankings to changes in these assumptions and analysis methods a series of sensitivity analyses were undertaken. These analyses involved the total versus partial solidification option, the provision of rail service to candidate sites and the method used to aggregate surface water factors.

E.2 TOTAL SOLIDIFICATION VERSUS EVAPORATION

The Phase 4A analysis and ranking of siting options from the surface water perspective was based on an assumption of total solidification. This assumption means that there will be no discharge of treated liquid effluent to surface waters.

The total solidification and evaporation options were still under consideration at the time of the ranking of siting options (Facilities Development Process, Phase 4A Report, OWMC 1985). Consequently, the surface water team undertook a sensitivity analysis to determine the effects of adopting an evaporation option on the ranking of siting options. Other partial solidification options are discussed in the report Site Selection Process, Phase 4A: Selection of a Preferred Site(s) - Site Selection (M.M. Dillon Limited, 1985a).

The sensitivity analysis indicated that a change from a total solidification option to an evaporation option would have no effect on the ranking of siting options from a surface water perspective. This is due to the fact that there would be no discharge of treated liquid effluent to surface waters under either option.

E.3 PROVISION OF RAIL SERVICE

During the Phase 4A analysis and ranking of siting options the provision of rail access to a candidate site was viewed an opportunity rather than as an absolute requirement. As a result, rail service to a site was not considered to be part of the basic facility design.

A sensitivity analysis was undertaken to determine the effect on the surface water ranking of siting options should the provision of rail service be included. The analysis was conducted at a broader level of detail than other Phase 4A studies.

The major benefit associated with the bulk haulage of process additives and reagents by rail would be a reduction in both road transport haulage and in the cost of transport of these materials to an integrated or partially integrated site.

The preferred rail access options to the candidate sites were identified in the overall site selection report (M.M. Dillon Limited, 1985a). These routes were examined to assess potential effects of rail access on surface water resources. A "number of streams crossed" factor was used to

compare the potential impacts on surface water from rail access routes. The siting options were then ranked. The results are presented below.

SITING OPTION	NUMBER OF STREAMS CROSSED	RANKING	COMMENTS
LF-4N/PI-13N	N/A	N/A	Rail service not provided. There would be no negative effects on surface water.
LF-3C	0	1	
LF-1E	0	1	
LF-1E/PI-27E	0	1	
LF-4N/PI-1N	0	1	
LF-9C	2 minor	2	Slightly less preferred than other options due to crossing of 2 minor streams.

The provision of rail service would be considered as an impact factor. Impact factors are ranked lower than risk factors in accordance with OWMC's site selection goals. The surface water factors used in the detailed comparative evaluation and ranking of siting options were risk factors. The inclusion of rail service as a consideration in the analysis would therefore be minor. Furthermore, the differences among the options with respect to rail are slight (i.e. no streams

crossed to two minor streams crossed). In fact only one site is negatively affected by the rail option, i.e. LF-9C.

The proposed rail alignment at LF-9C crosses two minor streams (see Figure 17). These streams are intermittent and have small upstream drainage areas. The anticipated environmental impacts of rail crossings of these two streams were not considered significant enough to affect this site's ranking.

Should this factor be considered in the surface water team's detailed comparative evaluation of siting options it would not alter the ranking of siting options presented in Section 3.9.

E.4 FACTOR AGGREGATION METHODOLOGY

The method used to aggregate factors and produce a ranking of the siting options from a surface water perspective is discussed in Section 3.8 of this report. In this procedure the two factors in the surface water suitability factor grouping were combined to produce a single suitability rating that was then used to rank the siting options. The surface water factor in the Transportation Risk factor grouping was not included in the surface water ranking but was provided to the M. M. Dillon transportation consultant and incorporated in the combining of the transportation factors. This process and the relationship between consultants is depicted in Figure 22 on page 75 of this report.

To provide a ranking of siting options for the surface water discipline the detailed comparative evaluation presented in Section 3.8 was modified to include all three surface water factors and repeated. A description of the analysis and the resulting ranking of siting options for the surface water discipline is presented below.

In this analysis the following three surface water factors were combined to produce a single suitability rating:

1. Suseptibility of the Site to Flooding,
2. Potential for Water Use Interference, and
3. Transportation Risk to Surface Waters.

The first step in combining these factors was to rank them. The factor ranking and the rationale for the rankings is presented in Table E.1. The Potential for Water Use Interference and Transportation Risk to Surface Water factors were ranked equally and highest. The Susceptibility of the Site to Flooding factor was considered to be of secondary importance.

Next a seven level ranking system similar to the one used in Section 3.8 and shown in Figure 24 (page 110) was developed for the surface water discipline. The suitability levels are defined in Table E.2.

TABLE E.1 SUMMARY OF FACTOR RANKINGS

FACTOR	RANK	RATIONALE
1. Susceptibility of Site to Flooding	3	- severity and frequency of flooding expected to be low at most sites; - area affected by flooding is relatively small contrasted to large potential area that could be affected downstream of access routes and the waste treatment facility; - flooding concerns can be mitigated, and are addressed in the preliminary facility design; - sites have been previously screened for major flooding constraints.
2. Potential for Water Use Interference	1	- potentially severe if release of untreated waste into watercourse and direct human consumption; - potentially large downstream area could be affected; - althnough it is possible to warn downstream users and provide alternate water supplies in case of contaminants entering a watercourse it may not be possible to completely avoid human consumption; - sites have been previously screened for major sensitive water uses such as a municipal intake but low-volume water uses downstream of sites exist; - lateral migration of contaminants to surface water by means of fracture zone a potential concern.

TABLE E.1 (cont'd)

FACTOR	RANK	RATIONALE
3. Transportation Risk to Surface Water	1	- potential for spill entering a water course and subsequent consumption by humans is remote; however, should it occur the effects could potentially be severe; - potentially large downstream area could be affected; - although it is possible to warn downstream users in the event of a spill there may still be some human consumption, by humans.

TABLE E.2 DEVELOPMENT OF RELATIVE SUITABILITY RATINGS FOR THE SURFACE WATER DISCIPLINE

RELATIVE SUITABILITY LEVEL	RELATIVE SUITABILITY LEVELS FOR FACTOR			SITING OPTIONS	RATIONALE
	FLOODING	WATER USE	TRANSPORTATION		
-6				None	
-5	-5*	-3	-5	LF-3C	- highest level of constraint
	-3	-5	-3	LF-4N/PI-13N	- water use and transportation are highest ranked factors
-4				None	- potable uses downstream from LF4N/PI-13N - LF-3C highest transportation constaint - LF-3C slightly more constrained than LF-4N/PI-13N due to flooding
-3	-1	-3	-4	LF-9C	- middle level of constraint
	-3	-3	-3	LF-4N/PI-1N	- slightly higher transportation constraint for LF-9C offset by lower flooding constraint than LF-4N/PI-1N
-2				None	- water use and transportation constraint similar and at a middle level in relative term
-1	-2	-1	-1	LF-1E/PI-27E	- lowest level of constraint
	-1	-1	-1	LF-1E	- lowest water use and transporation constraints - lowest flooding constraints - LF-1E/PI-27E has a slightly higher flooding constraint.

* See Table 22 for development of relative suitability levels for these factors

Finally the relative suitability levels for the surface water discipline contained in Table E.2 were used to provide a ranking of siting options. Options are ranked in Table E.3 in order of preference.

TABLE E.3 RANKING OF SITING OPTIONS - SURFACE WATER DISCIPLINE (INCLUDES TRANSPORTATION FACTOR)

MOST PREFERRED	SITING OPTION	RANKING	RELATIVE SUITABILITY RATINGS
	LF-1E	1	-1
	LF-1E/P1-27E	2	-1
	LF-4N/P1-1N	3	-3
	LF-9C	4	-3
	LF-4N/P1-13N	5	-5
	LF-3C	6	-5
LEAST PREFERRED			

RATIONALE

Integrated site LF-1E was ranked first from the surface water perspective. It had the lowest intensity of surface water use of all sites. The downstream water use index and the transportation suitability rating were the lowest of all options. Furthermore, there were no potable uses immediately downstream from the site. Flooding constraints with this site were considered to be minor and are easily corrected. The relative suitability level was -1.

The partially integrated site LF-1E/PI-27E was ranked second. The comments concerning option LF-1E above also apply to this siting option (with respect to the landfill located on LF-1E). This option was slightly less preferred than LF-1E (integrated) due to minor flood constraints that are associated with site PI-27E. The relative suitability level was -1 (i.e. the same as LF-1E integrated).

Option LF-4N/PI-1N (partially integrated) was ranked third. The water use downstream (as measured by downstream water use index) from this siting option was slightly greater than previous options. No potable uses were identified downstream from these sites. The transportation suitability rating was greater than previous options. This siting option was considered to be moderately constrained due to flood susceptibility. The flooding concern was with respect to the proximity of the Indian Creek floodplain to site LF-4N; however, these floodlands can be avoided. This siting option received a relative suitability rating of -3.

SITING OPTION LF-9C was ranked fourth, only slightly less preferred than option LF-4N/PI-1N. (Both options received a relative suitability rating of -3). The downstream water use index was similar to LF-4N/PI-1N and LF-3C. The transportation constraint rating was slightly higher than LF-4N/PI-1N and slightly less than LF-3C. Flooding constraints associated with the site were considered to be minor and mitigatible.

SITING OPTION LF-4N/PI-13N was ranked fifth. The main reason for this siting option's low ranking was due to the occurrence of potable water uses from streams downgradient from the facilities (PI-13N). These potable uses, coupled with the fact that this siting option had a high downstream water use index resulted in the highest constraint ranking for water use. The transportation constraint rating for this option was moderate (-3) and was the same as LF-4N/PI-1N but less than LF-9C and LF-3C. Flooding constraints were associated with LF-4N (discussed previously) and were considered to be avoidable. The relative suitability rating for the option was -5.

SITING OPTION LF-3C was ranked sixth. This option was slightly less favoured than option LF-4N/PI-13N. (Both options received a relative suitability rating of -5). The water use constraint for this option was considered to be moderate (-3) and similar to LF-9C and LF-4N/PI-1N and less than LF-4N/PI-13N. The transportation constraint for LF-3C was the highest of all options. LF-3C also had the highest relative constraint due to flood susceptibility as a result of the proximity of the Beaver Creek and Welland River floodplains.

CONCLUSION

The effect of aggregating the three surface water factors on the ranking of siting options can be observed in Table E.4. The arrows indicate the changes in ranking of siting options and their respective relative suitability ratings as a result of the inclusion of the transportation risk-surface water suitability factor in the aggregation process.

The transportation risk - surface water suitability factor was highly ranked (equal to water use interference and greater than flooding). The inclusion of this factor results in access routes having high SPIs and DSWUIs being ranked less favourably than they were in the previous analysis.

Options LF-1E and LF-1E/PI-27E are unaffected by the inclusion of the transportation factor because they have very low SPIs and DSWUIs. The remaining siting options, however, become less favourable with the inclusion of this factor. The greatest change is with siting option LF-3C which moves from 5th ranked to 6th ranked and from a relative suitability rating of -4 to -5. This is due to this siting options' large SPI and DSWUI. Site LF-9C also moves down in the ranking (from 3rd ranked to 4th ranked) as a result of its large SPI and DSWUI; however, the relative suitability rating of LF-9C does not change (i.e. -3).

TABLE E.4 EFFECT OF FACTOR AGGREGATION METHODS ON RANKING OF SITING OPTIONS

	SITING OPTION	RELATIVE SUITABILITY RATING
Most Preferred	LF-1E LF-1E/PI-27E	-1
		-2
	LF-4N/PI-1N LF-9C	-3
		-4
	LF-4N/PI-13N LF-3C	-5
Least Preferred		-6

* Arrows indicate shifting of rankings